THE

ELEMENTS OF PHARMACY,

AND OF THE

CHEMICAL HISTORY

OF THE

MATERIA MEDICA:

CONTAINING

An Explanation of the chemical Processes of the London Pharmacopœia on the different Theories received at present:

The chemical Properties of the various Articles of the Materia Medica of the London College; and of other Drugs that have been lately introduced into Practice:

A Description of the most approved Furnaces actually used in the Practice of experimental and manufacturing Chemistry; illustrated by Figures.

The Whole intended as a Companion to the Author's Treatise on Pharmacology.

BY

SAMUEL FREDERICK GRAY,

LECTURER ON THE MATERIA MEDICA, BOTANY, AND PHARMACEUTIC CHEMISTRY.

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Cui nec aulæ splendor, nec œconomiæ ratio, nec famæ integritas, nec sanitatis vigor, quicquam præ carbonibus, venenis, fuligine, follibus et furnis valere potest.

BECCHER. *Phys. Subt.*

S. Gosnell, Printer, 8, Little Queen Street, London.

TO

THE STUDENTS

WHO HAVE ATTENDED

THE

AUTHOR'S LECTURES,

THIS WORK IS DEDICATED;

WITH

HIS MOST EARNEST WISHES FOR THEIR SUCCESS

IN LIFE.

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PREFACE.

The Treatise on Pharmacology, usually called the Supplement to the Pharmacopœia, presented to the medical student and the tradesman connected with medicine, a manual of the uses of natural substances employed in medical practice, and a very large collection of the methods which are used, not only for preparing medicines as desired by the Fellows of the metropolitan and provincial Colleges of Physicians in the British Islands, but also those cheap imitations of them which are required by dispensaries, and the contractors for doctoring the parish poor, or plantation slaves; and moreover, the preparation of many other articles, which are usually sold by the same tradesmen as supply sick persons with the medicines ordered by their medical attendants. The present work is intended to explain the principles upon which the processes mentioned in that work are founded.

With this view, the means of research are first considered generally: as the structure and use of the thermometer, the balance, and the weights and measures, now used in this country; respecting which, there is given a historical account of the introduction of the several species of weights and measures into this country, and tables, not only of the Roman weights, still used by Latin writers, but also of those of the Saxons and Danes, from whom some of our weights are derived. Nor are the French, German, and Swedish weights and measures, often mentioned in chemical works translated from those languages, left unnoticed. This is succeeded by an account of the different methods of ascertaining the density, or specific gravity of substances; and the mode of operating upon the various species of air, or what are now more usually called by their Flemish name of gas introduced into chemistry by Van Helmont.

To this succeeds an account of the various apparatus for exhibiting heat, according to the actual usage of England, which differs much from the Continental; and in this are introduced sections of the different furnaces, all drawn to one scale, namely an inch to a foot; by which means their relative sizes are determined by mere inspection, and their actual size may be easily determined by the application of a common rule: as three quarters of an inch will represent nine real inches; half an inch, six real inches; a quarter, 3 real inches, and so in proportion. And this is followed by a slight notice of the electrical and galvanic apparatus.

It may sometimes appear, as though neatness in apparatus was discommended, but this is only in those points wherein accuracy and elegancy are needless, as in furnaces, troughs for operating on gases, pipes with a multiplicity of stopcocks; for in these points, cheapness and simplicity are certainly the main qualities to be sought after: the showiness and complication frequently visible in these apparatus, being only fit for the show laboratory of a mere feeble amateur of chemistry, or of a public lecturer whose principal object is to attract an audience.

There are other instruments of research too much neglected, in which the greatest cost and expense cannot be deemed superfluous in regard to their accuracy, not their materials: such as balances, piles of assay or commercial weights, foreign weights, which are much quicker reduced to English by being put into the scales than by calculation, and thus much time may be saved; foreign measures; graduated measures and assay tubes; linear measures and beam compasses; thermometers of various constructions and with several scales; goniometers, to measure the angles of crystals; the various apparatus to examine the phenomena occurring in the transmission of light, or illuminating pulses.

The theoretical part commences with an enumeration of the several substances considered as simple bodies, or remote principles, by the various sects of chemists. And in this part are also explained the different nomenclatures by which some chemists have not only attempted to denominate new substances, so as to exhibit their composition on the principles of that sect to which the writer adheres, or to relate historically the properties common to several substances, which vary from each other only in the quantity of water which they contain, or some slight additament which may be considered merely as an accidental foulness; but also to alter the established language of the country, even in respect to those bodies which are the most extensively known, and whose names are in the mouth of every person of the most tender age.

It is indeed true, that the regularity of the chemical language, introduced of late years into the different schools, usually strikes those beginning to study chemistry in any one school, or by any single book, as a great improvement and a means of facilitating their progress; but as they proceed in their studies, and meet with books written in the differently constructed nomenclature of another school, they soon discover the futility of this opinion, by reason of the continual changes which have been constantly made in the theory of the science, even in the same school, or the different views that different schools have taken of the same subject, and the consequent uncertainty of the substance to which the writer refers, when he uses the slang of his own school, and it happens to clash with that of another school. The following substances, of very usual occurrence in pharmacy, are continually confounded, namely, magnesia alba and calcined magnesia, both of which are called simply magnesia; salt of tartar or of wormwood and aërated kali, both called carbonate of potasse, with many variations of spelling; corrosive sublimate and calomel, both of which are confounded under the common name of muriate of mercury. In this latter case, the mistake may be of serious consequence, the first being a most virulent poison, the latter a powerful medicine. To say nothing of the equivocal signification of the words antimony, cobalt, nickel, manganese, which whenever they occur, require consideration whether they are used in the common sense or in that of the modern chemical schools.

The great error has been the confounding the appellative names of substances, with the theoretical phrases denoting their composition, which may be occasionally used in the schools, for the purpose of more conveniently and concisely explaining the mutual action of the bodies upon each other. Although senseless substances have no individual legal rights to reclaim, yet their names having once become public property, ought no more to be altered, on the score of impropriety, than the names given by parents to their children, although these proper names do in many, nay, in almost every instance, but ill agree with their future employment or rank in life. On the same grounds, we must object to the name of our own sovereign, for George signifying in Greek a cultivator or farmer, is certainly in its etymology too mean and too ridiculous for the name of the illustrious chief of the British and Hanoverian nations; and, on the same principle as that by which the names of chemical substances are continually altered, an historian writing his life and actions, might full as well new name him Waterloo, or Theophilus, or make any other similar change, to the great confusion of his readers. Into what difficulties has the practice of some of the Asiatic sovereigns in changing their names, or rather ordinary titles, to suit particular circumstances of a temporary nature, plunged their history? What trouble must it not have cost Dr. Prichard to explain, as he has very satisfactorily done, the dynasties of Egypt? Who can now unravel the series of the sovereigns who have reigned on the banks of the Tigris and Euphrates, principally from this cause, but in some measure also from their names or titles being translated into other languages, instead of the original terms being retained? The French have introduced a similar confusion into geography, by new naming the places in the Pacific Ocean, in order that their countrymen may suppose them to be discovered by French commanders.

The following seem to be the true principles on which things ought to be named in books:

When the same substance is known in different parts of the country, or in different arts, by a different name, that used by the most numerous class is to be preferred.

When the same substance has two names in equally common use, which must be a rare case, if it occurs at all, the name expressing some striking property of the substance, or one whose etymology is either unknown, or not very obvious, is preferable to a name expressing the theoretical composition, as this last may perhaps be found to be erroneous, even before the book is finished.

The affixing names to newly-discovered substances, or making the necessary additions to distinguish such substances as have been confounded under a single name, belongs undoubtedly to their inventor or distinguisher. If he bestows on them a name which future discoveries show to be false, or the opinions of another sect conceive to be erroneous, it ought not to be changed (although in some cases it may be contracted by the omission of part thereof), for it will at any rate show the opinions of the day, or those predominant in the discoverer's mind at the time. If he gives it a ridiculous name, it must remain a memorial of his want of taste: since the use of the most erroneous or the most ridiculous name imaginable, is a far less evil than that multiplicity of names to the same thing, which has of late been introduced, by every theorist being allowed to change the names of substances so as to suit his own ideas of their composition.

When indeed several substances, by differing only in the quantity of water that they contain, or by some slight addition of another substance, which may be looked upon as an accidental foulness, have nearly similar properties, and it is desired to express only the qualities that are common to the whole assemblage, either the name of the purest substance or that of the most common, may be used as a type of the genus; or a new name may be taken to comprise the whole, as vitriolic acid was used to comprise the Nordhausen fuming oil of vitriol; English oil of vitriol, formerly called oil of sulphur by the bell, and spirit of vitriol. Care, however, must be taken in the using of those generic or family names, that properties belonging to some only of the species be not ascribed to the whole of them. Thus, it is false to affirm that vitriolic acid, or as it is now more usually called sulphuric acid, rapidly dissolves iron, and that hydrogen gas is emitted; for this is true only of the diluted acid, or spirit of vitriol, the presence of a large proportion of water being necessary for the oxidation of the iron, and the consequent emission of hydrogen gas; whereas the concentrated acid, or oil of vitriol, requires to be boiled on the metal, and being thus obliged to part with some of its own oxygen to oxidate the iron, and render that metal soluble in itself, vitriolic acid air, or sulphurous acid gas, is emitted instead of hydrogen gas.

When once these generic names have been promulgated, there seems to be no more reason to change them, than for changing the specific names of the things themselves; and yet almost every school varies them. For example, how many alterations have been made in the naming of the vegetable fixed alkali, since its identity has been determined: it has been called the alkali of tartar; the alkaline basis of salt petre; potash, which is equivocal in English as signifying the impure fixed salt obtained from the ash of the roots of trees burned for that purpose; potasse, equally equivocal in French, but which seems the best single word that can be used in English, as well in regard to mildness of sound, as in respect to our common practice of adopting French words for things which have as yet no names in our tongue; potassa, free indeed from any equivocal meaning, but objectionable on etymological grounds, for, if deduced from potash or potasse, it has not the termination used either in our own or the French language, to form any kind of derivative nouns, and there is no Latin primitive from whence it can be analogically derived; potass, in respect to which it may be observed, that although our northern fellow islanders may pronounce this word, as well as sulphat, nitrat, carbonat, and the like, and their ears may tolerate the sound, yet to English ears they are all certainly too grating to be ever current in the south. Dr. Black, commonly taken for a Scotchman, yet both by birth and the most strongly marked physiognomical expression, a Frenchman, proposed lixiva: Bergmann, potassinum; Hopson, a Greek derivative, spodium; Kirwan, tartarine; and both Klaproth and Berzelius denominate it kali, a name used in the London Pharmacopœia, edition of 1788, and still retained in common use amongst druggists. There is scarcely a well known family of chemical substances, or even single substance in general use, but has been similarly stocked with an equal variety of names to the great confusion of the student, and every year adds to their number.

As this work is of an elementary nature, the order in which the substances whose chemical history is given, are placed, is not fortuitous, as it may at first sight appear. They are, in fact, so arranged that the chemical history of the materia medica may be gradually unfolded, the knowledge of those placed first in the series being necessary to the understanding of those placed in the latter part. The general order of the series is this, atmospheric air, water, charcoal, metals, sulphur, mineral acids, stony and earthy bodies, alkalies, bone ash, and sal ammoniac. Then follow the laws of combination, and the doctrine of heat and fire. After these, the history of the compound combustibles, or organic substances, has its place, which is necessarily confined to those mentioned in the London Pharmacopœia, with the exception of a few others; some of which have been introduced into medicine since the publication of that work, or, to speak more properly, their use has been revived; and others are necessarily introduced as being mentioned in the history of the substances which follow in the series.

The account that is given of the metallurgic speculations of the older chemists, will be found much fuller in its details, especially of the practical part, than in any other publication. It may seem as though it were unnecessary at this time to have entered upon the subject, because in public company the pursuit of alchemy, like the belief in ghosts, is derided; but, as faith in the latter is often manifested by the fears of those who loudly maintain the non-existence of apparitions, so there still exist those who in private recesses attempt the solution of alchemical problems, upon various different theories. The mercurification of metals, or their change into quick silver, another problem whose solution was attempted by the old chemists, has been omitted in the work. There are two principal methods in which it has been attempted: either with or without saline substances. In the first method, the metal was most usually macerated, or distilled with common salt; the quick silver when it is obtained, for no certain process has been delivered, is thought by some to have pre-existed in the common salt, as it is also believed to exist in the waters of the sea; but on this point, others are sceptical, especially as quick silver is also said to have been procured from metals, by means of ammoniacal salts, or by salt of tartar, an observation which seems to have some relation to the alloys of potassium or to the metallization of ammonia, discovered by Pontet and Berzelius. As to the mercurification of metals without salts, the process given by Stahl is briefly this: a regulus of antimony is prepared by means of iron, in the usual way; some of this regulus is melted with twice its weight of silver, and then amalgamated with a triple weight of quick silver. This amalgam is digested, and a powder being flung out, it is ground with water, until it appears bright and clean. It is then distilled, and the remaining silver melted with fresh regulus of antimony, and again amalgamated with the same quick silver. By a repetition of this process for several times, the quantity of the quick silver is increased, and it acquires the singular property, common to several of these metalline mercuries, of growing hot on gold being dissolved in it. The Hon. Mr. Boyle not only bears testimony of this incalescence, as it is termed, but also, that whereas quick silver amalgamated with gold is oxidized quicker than when boiled by itself in an open vessel, he had kept amalgams of gold, made by these mercuries, in a considerable heat for more than six months, without obtaining a single grain of oxide.

Part of the neglect of the old writers on chemistry, may be ascribed to the diffuse style, and the frequent admixture of religion in their works. Although the style of these writers appears disgusting at present, it seems to have pleased the readers of their age far better than the simple and unadorned diction of modern authors, if we may judge from this circumstance: the Basilica Antimonii of Hamer Poppe, a well-printed quarto pamphlet of 50 pages, published at Frankfort in 1618, but in the Roman type, giving an account of antimony, its various names in different languages, its separation from its ores, its various preparations under distinct heads and their uses, without the least rhetorical colouring, but perfectly resembling, in simplicity of manner, arrangement, fulness of information, and even its excellent typographical execution, the modern papers in the Philosophical Transactions of the Royal Society of London, does not seem to have attracted any notice; while the Currus Triumphalis Antimonii of Basil Valentine, or John Tholden, be it whose it may, containing far less information, mixed up with a very large proportion, more than half the work, of pretended religious fears, lest the author had let some direful secrets escape him, which the reader might misapply, and a plentiful admixture of medical boasting, went, about the same time, through a number of cheap editions, was translated into all the principal languages of Christendom, and is conceived by some to have given a considerable impulse to the study of chemistry.

It must also be considered, that most of the old chemical books were written by the clergy of the Romish church, who being accustomed to treat of the subject of their profession in a metaphorical and mysterious manner, in order to give it a more lovely or terrific appearance, according to the object they had in view, either to allure men to place confidence in them, or to lay before their hearers the consequences of not submitting to their guidance; were naturally led to use the same style in the other branches of their studies. And their persecution of the students of chemistry under the odious name of magicians, arose from the fears of these clergy, lest the surprising alterations produced in bodies by means of chemistry, should weaken, as they have actually done, the popular faith in the miracles these clergy were then in the habit of exhibiting; and the circumstances of the times, the Roman Catholic clergy being then the paramount profession in Europe, indeed the only one that had any permanent organization; hence, as they were without any political balance in the state, and were opposed by no clashing sect of sufficient power to counteract their unlimited authority over the popular mind, they consequently lorded it with so high a hand, that one King of England submitted to be whipped by them at Canterbury; another, after nineteen years' sturdy resistance, was obliged to surrender his crown into their hands and receive it again from them as their feudatory; and the Emperor of Germany and his Empress were fain to wait barefooted, in winter, for some days at the Pope's gate to crave audience, which was only given him, as he held the stirrup while the Pope got upon his mule. In these transactions of the Papal clergy were probably reacted the enormities of the priests of Saturn, before the followers of the milder religion of Jupiter had, like the Protestant princes of latter days, supplanted them in their authority, and established a political balance between the ecclesiastical and civil powers. And in them we may probably behold, as in a speculum, the state of Europe two or three centuries hence, when the human mind, continually librating, and having some time since reached the utmost limit of liberality and toleration, shall have again swung over to the opposite extreme point of superstition and intolerance, under the influence of another deluge of credulous and cruel barbarians, from the steppes and forests of Russia, crouching themselves to the ignorant papas of the Greek church, and forcing the southern nations to do the same by the terrors of the knout and the bayonet.

The indifferentism, or balanced state of opinion, produced in the mind by a due reference to this constant libration of human opinions and affairs, as shown by the history of states and of the sciences, is of the utmost consequence for the student to acquire; it being a due mean between absolute scepticism on the one side, and implicit belief in the leader of a sect on the other. He who doubts of nothing, knows nothing properly, for doubting is the first step to our proper knowledge of a thing. The disbelief without examination, or the belief of any thing without any other reason than that their master said so, is equally inimical to a healthy state a of the intellect.

Although this work is intended only as an introductory treatise to the study of the materia medica and chemistry in general, yet a few subjects shall be here noticed, which are connected with the study of young men, whatever may be their destination; namely, the disposition of a library, and the forming a catalogue of it; the keeping a record of their transactions, observations, and reading; and lastly, some account of the attempts to improve the memory when it is apt to fail.

Those students who do collect books will find it useful, in many respects, to have a catalogue of their library, however small it may be, without waiting until the number of the books renders the formation of a catalogue an appalling task. Simple as a catalogue of a library may appear, many plans have been proposed and followed, all which have some advantages, but are attended with their peculiar inconveniences. A good catalogue of a well disposed library requires six distinct points to be observed; namely,

1. That it should admit of continual additions, without any alteration of its original plan.

2. That there should be an easy reference from the catalogue to the books themselves, or the contrary.

3. That the books, after having been taken down for use, may be readily replaced.

4. That if any books are taken down from their place, the absence of them may be readily discovered.

5. That the works of any author, or commentator, may be speedily found in the catalogue.

6. The like in respect to the works upon any particular subject.

To combine all these advantages is not easy. The first requisite forbids classification, and requires that the catalogue should proceed on as the books are obtained.

The three next requisites make it necessary, considering that the books must be placed on the shelves according to their respective sizes, that these sizes should be mentioned in the catalogue, and that each volume should have marked on its back, and also, for fear of accident, on the first and last leaf, two numbers; one series running on regularly in the order in which the volumes occur in the catalogue, and alone marked in the catalogue, unless in the case of additional volumes to a set being procured, which must also have a marginal reference to the number under which the former volumes of the set was originally entered; the other series being confined to each particular size, and in which the several volumes of a set, provided they be of the same height, are all numbered the same as those that were first procured. Then the books being placed upon the shelves in the same order as they, or their first volumes when in sets, occur in the catalogue, the first, or catalogue series of numbers, will fulfil the second requisite; and the second series of numbers fulfil the third and fourth requisite; as the absence of any book will be readily discovered by running the eye along the numbers as they stand on the shelf, to see if there be any break in that second series of numbers; should any happen to be discovered, a reference to the catalogue between the first number of the book preceding the break, and that following it, will soon show the identical book that is missing. The first set of numbers will exhibit the total number of volumes of which the library consists; and if the prices of the books be added in a set of money columns, the addition of them will show the cost of the collection. In large libraries, some works of more than ordinary beauty or value will of course be kept separate, and have a peculiar catalogue. As to periodical publications, they also require a separate memorandum to be kept of their receipt, until they are made up into volumes. In very large libraries, as the numbers, where they exceed four places of figures, would take up too much room, it will, on completing the first myriad, be best to begin a fresh series of numbers, distinguished by prefixing 1) to them, and repeating this stop as often as may be necessary.

The fifth and sixth requisites are only attainable by an alphabetical index of the names of the persons and things mentioned in the titles of the books, referring to the numbers of the catalogue. As, however, several small tracts are often bound up in the same volume, a practice much to be condemned, and the subjects of books are often very obscurely marked in their titles, it will often be necessary to enter in the catalogue a sketch of the contents of some volumes, especially if they are of a miscellaneous nature. The extent to which this analysis should be carried must depend upon circumstances; thus a chemist, on entering a volume of the transactions of a philosophical society, or of a periodical miscellany, will do well to notice in the catalogue the subject of any chemical paper or observation that may occur therein: by which means a reference to them will be brought into the indexes.

The making of indexes, when of considerable magnitude, is a laborious work at all times, and especially if the person is not accustomed to the employment. From no little experience it has been found, that indexes are most conveniently made by folding sheets of paper into two or more columns, and then entering from the catalogue the various names and subjects as they occur, affixing to each the proper numerical reference, and underlining the words in the catalogue which have been noticed, in order to exhibit the progress that has been made. These references are then to be cut, first into columnar slips, and then each slip into as many pieces as there are references; which pieces are to be dropped, as they are cut, into boxes or heaps, one for each letter of the alphabet, placed before the index maker in two or three rows, the first letters of the alphabet, as most frequently occurring, being placed next to him. These heaps or collections are then to be similarly subdivided by their second letters, and again by their third, and so on until they are brought into strict alphabetical order. The slips are then to be pasted on one side only of leaves of strong paper, which if blue renders them more distinct; and it will be necessary to leave very sufficient spaces to paste in additions. It will be still more convenient for these additions, if the sheets of paper, instead of being bound up, are kept in expanding portfolios, made of pasteboards cut to the proper size, with two or three tapes run through holes in their sides, so that, whether few or many sheets are kept in them, they may always be drawn tight. If it should chance that sufficient room has not been left on any of the sheets for the necessary additions, it is to be cut through where the addition is required, and each part made into a whole sheet by the pasting on of the requisite quantity of paper.

The recording of the facts observed by a student, an abstract of his reading, and his thoughts, is truly his mental stock, by the due use of which he may hope in time to augment his more substantial stock of the good things of this life; yet as this is only eventual, and this mental stock is, when first acquired, readily recalled by the memory, students are too apt to neglect this tedious labour. Few, however, are the men who do not deplore the want of having recorded some fact or observation that formerly occurred to their notice, but of which they have forgotten the details, or the book in which they found it, and cannot by any exertion of memory recall it to their mind.

To avoid this unpleasant occurrence, which is often the occasion of considerable loss of time, and frequently, after every possible exertion, the pursuit obliged to be given up in despair, it behoves every person to keep as accurate a record of every thing that occurs, and even of every thought that passes through his mind, which may in any respect bear upon his future prospects in life, as of the most considerable money transactions, seeing that the former may eventually be of as great importance.

Part of this neglect may be ascribed to the register not being at hand; and while the materials of writing are sought for, and the book got ready, the mind has in the mean time passed to another subject, and the interest of its former thoughts has diminished. It is astonishing how careless even professed authors are of having their writing materials ready. While the most paltry dealer has his desk and his books ever open to record his twopenny debts, every man of education ought surely to have the same means of writing equally ready at hand in his usual sitting place. It is even of consequence that the book be open at the very place, as the delay will otherwise be frequently fatal to the recording of many things that will be regretted at some future period.

Several schemes have been proposed by different authors for registering merely luciferous affairs. That most commonly used in England, are the common places proposed by Locke. The celebrity of his name has given it a currency far beyond its real merit. His plan is to enter all facts, observations, and thoughts, under some determinate leading word or phrase, which are technically called common places. These leading words he arranges according to their first letter and first vowel not beginning the word, if there should be one in it. If not, the vowel that begins the word is considered in a double capacity. To each of these classes he allows, when they are wanted, a page, or an opening, of the common-place book. Instead of entering the leading words in an index, he merely puts at the beginning of the book a list of these classes, as Aa, Ae, &c. Ba, Be, and so on, referring to the several pages where the words which agree in the first letters and vowels are placed. But unless a student pursues a very confined range of study, and his mind is equally poor in thoughts, or unless he has a number of common-place books, and allots one to each branch of human knowledge, all these divisions of the book will exhibit at the best a mass of matter, nearly as miscellaneous as if no selection were attempted, which will easily be seen upon reflection. And this mode of common-placing has not only the inconveniency of requiring thought as to the most proper leading word under which to arrange the intended matter; but also to refer to the index, and then turn over the book to find the place assigned for words beginning with those letters: a tedious process, that soon disgusts the student, and is fatal to the survival of many observations that would otherwise be registered.

The method therefore of keeping an adversaria, or simple memorandum-book of a sufficient size, always open on the desk, is far preferable. In this book the student should enter indiscriminately every thing that deserves recording, except such transactions as are entered in his commercial account books, if he keeps any; the observations of each day being separated by a line, with the date inserted in it, and the paragraphs of each day numbered for the sake of easy reference.

A margin of about one fourth of the breadth of the page must be left on one side of it, for the insertion, at some convenient time, of certain leading words expressive of the contents; so that by running the eye down this margin, the several subjects may be discerned with ease.

It will not be necessary to finish one subject before another be commenced, all that is required being to begin a new paragraph; and thus two or more subjects may be entered at once: the connexion between the several paragraphs that relate to the same subject, but which have other matter interposed, being readily made by a double reference; one even with the first line, referring by the date and number to the former paragraph on the same subject; the other even with the last line, and referring, in a similar manner, to the next paragraph. These references may be inserted either in parentheses in the body of the writing, or on the same margin with the leading words of the subjects; but it will in general be found best to have another margin of less breadth on the other side of the page, solely for this purpose.

In registering observations from verbal information, or from books, the authority ought to be carefully quoted, and in the latter case, the edition, if there be several, with the volume and page, must be given ; and this is best done at the beginning of the quotation, lest it should be afterwards forgotten.

A similar book, but of a smaller size, should be kept in the pocket constantly, to enter whatever may occur when the student is from home.

To render this mass of observations readily available for use, an index must be made to them in the same manner as already described; the leading words being underlined as soon as they are entered in the index, and the reference being made by the date and paragraph. This index should be formed from the first, of a sufficient bulk, that it may admit very copious additions.

It is seldom necessary to abstract what may be found in books which the student means to keep in his possession; but it will be very convenient to make a note of any passage which it is probable will hereafter be of use; and this is most readily done by making a partial index to them, each slip having a concise reference to the book as well as the page, and the slips, then intermingled with those of the adversaria, into one common alphabet.

If the student intends from the first to publish a book, in which his collections will form a large portion, they may be written only on one side of the paper; for in this case he may cut out such as relate to the subject of his work, and sorting them, agreeably to his intended arrangement, will be saved the trouble of entirely rewriting them, especially if he has taken the precaution to make his abstracts with this circumstance in his view, and adapted his language accordingly, as he will then only have to connect them together, and erase repetitions.

If, indeed, a publication is the sole motive for making such collections, it may in some cases be advisable to draw up a skeleton of the intended discourse, numbering the different sections in the order in which it is meant that they should stand; then writing the several subdivisions at the head of as many sheets of paper, similarly numbered, these sheets may be filled up with matter as it occurs.

The labour of writing these adversaria induces most students to trust to their memory, and to endeavour to strengthen that faculty, or to adopt some of those artificial modes of recalling things to the mind which have been proposed. This reliance on the memory is the more readily embraced by pharmaceutic students, from the mode employed to initiate them into their profession, by taking them from school at an early age, and placing them out as apprentices. It is well known to schoolmasters, that a love of learning seldom shows itself before a youth has attained his sixteenth year; previous to that time letters are an irksome task, and therefore a young apprentice, with a Dispensatory, and it may be a Latin Dictionary, for his only literary companions, and without any competitor to excite emulation, does in most cases, not only unfortunately lose the little learning he has brought from school, but also that which is of more consequence, the habit of mental discipline and literary labour; unless, indeed, his mind is very happily constituted, or the youth has a master or friends that urge him to continue his studies, and take the trouble to survey his progress day by day.

This mode of initiating a person into a liberal, and in some degree literary profession, by taking him from school before he has got over the irksome difficulty of grammar learning, and has been entered into logic, is evidently erroneous. As apothecaries have lately ascended in the scale of society from being mere tradesmen, and become members of a liberal profession, their mode of education ought no longer to be conducted upon the old plan of apprenticeships, but changed so as to assimilate with their new station. And it were also to be wished, upon the same consideration, that the jealousies between the various practitioners of medicine and surgery, founded upon the different manners in which they have acquired their knowledge, would cease. Such jealousies, and the recent attempts at monopoly, are only pardonable in the uninformed mind of the lower classes of handicraftsmen. The endeavouring to confine the practice of medicine to those alone who have been educated in a certain manner is absurd. What can it import, whether a practitioner acquires his knowledge by the vulgar mode of apprenticeship like a common house carpenter, or by an academical education, or by assisting in his parent's practice, generally for a much longer period than any legal apprenticeship, or whether, when at full maturity of reason, he is led, by the irresistible impulse of genius, to desert his original destination in life, and engage in this laborious profession which requires unremitting attention, being denied the usual weekly rest of other modes of living; especially as the practice of medicine is principally founded upon happy scientific conjectures, for in scarcely a single instance do the effects so constantly follow the means employed as to allow of its being called an art.

Be this as it may, the young apothecary, emancipated from his servitude, and from motives of economy attending as many lectures at once as he can conveniently, finds too frequently, that the torpid and inactive state into which his mind has sunk during his apprenticeship, renders him incapable of receiving the full benefit of his attendance on these lectures, his mind not being able, for want of exercise, to retain them. Some have endeavoured to remedy this by taking notes, either in short hand, or in the common characters, which, when the words are as much contracted as is usual in short hand, can be written quicker than the arbitrary marks of short hand, and read by any one who has some previous knowledge of the subject. These notes are then proposed to be rewritten into the adversaria: but however zealously some may commence this task, it soon becomes exceedingly irksome, and seldom is it continued throughout a whole course.

The improvement of the natural powers of the memory has been attempted by the use of stimulants, either as errhines, or taken internally; but it is not probable that they can have any effect: medical interference seems limited to the preventing of indigestion or repletion by evacuants pro re nata. There have not been even wanting teachers of memory, who have proposed writing out the lessons to be remembered, and taking them by degrees in the form of pills into the stomach while fasting, a mode ridiculed by Erasmus, in his dialogue Ars notoria, but which seems to have been originally founded upon the undeniable fact, that but a small task should be committed to memory at one time; and this mode was, agreeably to the old practice of medicine while it remained in the hands of the priesthood, adopted to secure this object.

The only natural method of improving the memory, and which has been found highly beneficial, and practised for many years, is, on retiring to rest, in silence and obscurity, to meditate and rehearse mentally all the transactions of the day, however minute, in the exact order in which they took place. Should it be discovered that any thing is omitted in its due course, the process of reflection must be immediately stopped, a short space of inaction allowed, and then the meditation begun afresh from the very beginning. This exercise must be continued until the mind gradually acquires the power of recalling the objects which have been presented to it, in the same order as they occurred.

The two most usually adopted modes of artificial memory are those called local memory, and signatures. Local memory is mostly used to recall a series of transactions. A list is made of the rooms in the house where the student commonly resides, and they are subdivided into so many parts, so as to afford sixty or an hundred places; to each of these a number is affixed, beginning from the top and proceeding in a regular order to the bottom. These places, and their numbers, must then be fixed in the memory, by frequent repetition, so that they may both be recalled instantly, and rehearsed from any point either ascending or descending. This being done, the transactions to be remembered are feigned to have been done in these places; or if it be a list of persons that is to be remembered, they are feigned to have performed some action in them, the more ridiculous the better, as taking greater hold upon the imagination. If dates are to be affixed, then the persons must be feigned to have some instrument in their hands, or to be accompanied with one or more things whose figure may resemble the Arabic characters used in arithmetic, and thus express the date; as, for 1, a candle, staff, dart, fish, &c.; for 2, a swan, duck, goose, &c.; for 3, a triangle, trident, a three-legged stool, &c.; for 4, a quadrangle, die, &c.; for 5, a glove, sickle, shoemaker's knife, &c.; for 6, a tobacco pipe, &c.; for 7, a carpenter's square, an open razor, &c.; for 8, a pair of spectacles, twin apples, &c.; for 9, a burning glass, a twisted cane, &c.; for 0, an orange, ball, or any thing round. If a series of things are to be remembered, they must be supposed to be kept in the memorial places, according to their numerical order. Some persons have preferred to divide their usual sitting room into the required number of memorial places; or to construct an ideal building for that purpose.

The species of artificial memory called signatures, is that which has been mostly used by medical students, especially for the recollection of the uses of the several articles of the materia medica; and which was the more necessary formerly when the list of drugs kept in the shops amounted to above two thousand, or full ten times as many as at present, and the preparations were equally numerous. The medical virtues of a substance having been ascertained by experience, the teachers of the art of memory sought for some resemblance, more or less apparent, between the drug and the disease, either in respect to the colour, form, or some other sensible quality: as the yellow colour of rhubarb and of saffron, with the bile causing bilious diseases; the black spot on the corolla of eyebright, and its use in diseases of the eyes; the form of cassia fistula, and its use in emptying the intestinal canal; and applied these resemblances, or signatures as they were termed, to the purpose of recalling the uses of the several drugs to the mind. Crollius, in his small work De Signaturis internis Rerum, has gone through the greatest part of the materia medica in this manner; but being a disciple of Paracelsus, and a lover of the marvellous, he has viewed the subject in another manner, and instead of considering the resemblances which a quick fancy used to the solution of enigmas, conundrums, and the like, may find betwixt a drug and the diseases in which it is available, as mnemonic signatures only, has chosen to regard them in a higher light, and as the language of the Creator to man, impressed on all natural substances to show their use. By thus introducing a disputable principle, he has diminished the utility of this study of signatures, the only species of artificial memory that is at all applicable to medicine; but which labours under the defect of obliging a person to remember two things instead of one: it must, however, be allowed, that when one thing is presented to our view, another, connected in some measure with it, will more easily recur to our mind, than if this latter had no connexion with the subject before us.

It was intended to have added a chronological list of the principal chemical books, similar to the list of botanical works, given in the Natural Arrangement of British Plants, but it was apprehended that this would increase the size of the work to too great a bulk; and this was urged the more forcibly, because the chemists, like the surgeons, depending, perhaps too much, on their own personal experience, are little versed in the history of their art, and contenting themselves with a common manual or two, have no wish to collect a library. From whence they too frequently announce to the world some important discovery, as they fondly imagine, but which has, in fact, nothing wonderful in it, save only that the subject was perhaps 2000 years old at the moment of its conception in their brain. To avoid making this ridiculous figure in the world, whatever has been written previously on the subject ought to be carefully examined before any publication takes place, if it was not done previous to the investigation being begun. The latter is certainly the most prudent course, as it will, in the majority of cases, prevent much loss of time in making original researches concerning things which have been long ago examined and settled; and at all events will certainly show the way more clearly, than if the inquirer trusted to his own unassisted efforts.

The plainness of the language used in this Essay may be objected to, in many instances, by those who are bigoted to the use of technical expressions derived from the ancient languages, in preference to our native terms. It is, indeed, true, that so far as could be done without the appearance of pedantry, the use of the bastard English speech, commonly used in scientific books, is avoided. It were to be wished that English writers would imitate the Germans, and make it their pride to use the words of our own growth, instead of mincing the language of Rome, or Paris, cutting, snipping, and trimming Latin and French words, to make them appear like English. A little pains bestowed on this point, would soon show them that in richness of language, our English tongue, although written without help from strangers, yields not to any other. And this step would be attended with a great gain to authors themselves, namely, that their writings would then be understood by all, however deep the matter in itself might be; whereas at this time, our books on science are not readable by those who have not already learned the mixt tongue in which they are written. The custom of Pindar reading his poems to an unlearned old woman, and the more humble method of a certain writer of a French grammar, in submitting his English translations of the French examples to the correction of the children, who were his scholars, and had not begun to learn French, that he might give the real English phrases correspondent to the French, may be followed with advantage. That the plainest mode of writing may be attended with great fame to an author is shown by Voltaire, whose works, as the Monthly Review once very justly remarked, are read with equal delight by the master and his footman, and equally well understood by the latter as by the former. And it may be observed, that the purest idiomatical writers, Shakespear, Addison, and Goldsmith, retain their fame undiminished; while the affected euphuism of Lilie has long been consigned to oblivion, and the sonorous periods of Johnson are sharing the same fate.

It will neither be supposed, nor is it pretended, that no use has been made of the works of preceding writers. The author, therefore, considers it incumbent on him to acknowledge the great assistance he has received from the elaborate and valuable System of Dr. Thomas Thomson, and the equally valuable Dispensatory of Mr. Anthony Todd Thomson. From Bergius's Materia Medica e Regno vegetabili, much information has been obtained. The abilities of Berzelius are so generally acknowledged, that no apology is necessary for the author having, in general, followed his opinions. Lastly, though not least in value, the Pharmacology of Dr. Paris has been consulted throughout; but as only the pharmaceutical part has been made use of, the student will still find it very highly advantageous to consult it, in respect to the therapeutical consideration of the materia medica, as the means of curing diseases: in which respect there is certainly no English work that can be in any way compared with it.

No literary performance beyond the size of a pamphlet can be deemed complete, in the usual sense of the word, without a good index; yet the labour of making and digesting it is a duty that few authors will submit to themselves, though they may justly be supposed the best qualified to analyse their own compositions; and hence we find many otherwise valuable works much depreciated for a want of this useful appendage: to avoid this, a very full index has been added.

18, *Burton Street, Burton Crescent,*
1st November 1822.

ERRATA.

Page 15, l. 7 from bottom, *after* assaying *add* gold.

Page 88, l. 27, *for* muriatic superoxide *read* muriatous superoxide.

Page 141, l. 2 and 3 from bottom, *for* potash *read* potasse.

Page 227, the last line, *for* Acetosa *read* Acetosella.

ELEMENTS OF PHARMACY.

Chemistry.—The alterations and appearances that take place in the admixture of bodies, and the action of heat and cold upon them, are the proper objects of chemistry; which also endeavours to explain the production of similar phenomena when they arise from other causes.

Atmospheric Pressure.—The atmosphere with which our globe is surrounded is continually present in all our operations, unless it be purposely excluded by artificial means; the most general action of it being the pressure it exercises upon dense liquids, and the resistance thus made to their flying off in steam when heated. This pressure is measured by the barometer, which in its most simple form is only a straight glass tube, closed at one end, and about 33 inches long, filled with quick silver, stopped by the finger, and inverted into a basin filled with that metal. On removing the finger the quick silver subsides a little, and by attaching a graduated ruler to a cork floating on the quick silver in the basin, the height of that in the tube above the other may be ascertained, which in this country varies from 28 to 31 inches, according to the condition of the atmosphere. This pressure is also affected by the height of the place where the observation is made; becoming less as the instrument is carried up higher, or more in low situations, where of course a longer column of air presses on the quick silver in the basin, and forces it further into the tube than in high situations. The apparently void space in the upper part of the tube, is called the Torricellian vacuum. When the quick silver is boiled in the tube, and other precautions taken to prevent the access of air and moisture, this vacuum is usually considered as destitute of gravitating matter, although it more probably is formed of the highly rarefied vapour of quick silver.

Temperature.—Although the sensations of heat and cold are known to all, yet our senses do not allow us to form any accurate measure of the variations of heat and cold which are continually taking place, in consequence of the tendency of heat to become equally distributed throughout the surrounding bodies, but which tendency is perpetually disturbed by various causes, either natural or those artificially excited for the purpose of exposing bodies to the influence of heat or cold.

The heating of a body is almost uniformly found to increase its bulk, and a number of modes have been invented to measure the minutest changes thus occasioned. In general, the most convenient instrument for this purpose, provided the heat be moderate, is the thermometer; being a glass ball terminating in a long narrow neck. As quick silver expands the most regularly of any liquid, it is usually chosen to fill the ball. Sixty-three parts of quick silver measured at the temperature of melting snow, expand, by being heated to the temperature of boiling water, so as to fill the space of 64 similar measures. The size of the ball is regulated by this calculation, so that the freezing point, or that of melting snow, on the scale attached to the tube, and that denoting the boiling point of water, shall be in convenient parts of the tube. The intervening space was divided by Fahrenheit into 180 degrees. He called the boiling point 212 deg. and the freezing 32; the degrees being continued above and below those points as far as the tube will allow. This division is still used in England, but the Swedish and French chemists use Celsius's or the centigrade scale; the freezing point of water being marked O, and the boiling point 100 deg. The temperature of melting snow or ice is constant in every place, but water boils at a lower temperature in a high situation than in a low one, and even in the self-same place it varies according to the pressure of the atmosphere. The barometer, or weather glass, therefore, should stand at some stated height, usually 30 inches, when a thermometer is graduated, or an allowance of 1·92 deg. of Fahr. made for each inch more or less at which it stands. Water in a place where the barometer stands at 29 inches boiling at 210·08 deg. Fahr. and where it stands at 31 inches the water requires 213·92 deg. Fahr. to boil.

Decimal Fractions.—How these decimals are to be read, is usually puzzling to young chemists, nor do the modern books of arithmetic fix the notation. Some consider the decimal parts as mere appendages, and read the above numbers, one deg. nine, two of Fahr., 210 degrees, ought, eight, 213 degrees, nine, two; which mode presents no idea to the mind. Another method is to consider the decimals as abridgments of vulgar fractions, having for their denominators an articulate number, composed of an unit with as many cyphers as there are places of numbers in the decimal, so that they read the above, one deg. and ninety-two hundred-parts, 210 deg. and eight hundred-parts, 213 deg. and ninety-two hundred-parts, which is a better method than the preceding. In general, however, young students seem to form the best idea of decimal fractions by considering them as sums of various denominations crowded together, without that visible separation usually interposed between *£. s. d.*, cwt. lb. oz., or any other common fractional parts, and reading them as one deg. nine tenths, two hundredths, 210 deg. and eight hundredths, 213 deg. nine tenths and two hundredths.

As each degree of the centigrade scale is equal to 1·8 deg. of Fahr. scale, a temperature measured by it is converted into Fahrenheit degrees by multiplying the observed degree of Celsius by 1·8, and adding to the product the 32 deg. which Fahrenheit assigned to his freezing point. Thus, 17 deg. Cels. multiplied by 1·8 is 30·6, to which adding 32 deg. the sum is 62·6 deg. Fahr. Or, reversing the operation, if 62·6 Fahr. be given, deduct 32 deg. for the difference between the beginning of Fahrenheit's scale and the freezing point, the remainder 30·6 deg. divided by 1·8 gives 17 deg. as the corresponding deg. of Celsius's or the centigrade scale.

Weights.—The quantity of the bodies we employ in our experiments or operations, is most accurately determined by their weight; but that this weight may be communicated to others, it must refer to some natural standard. For this purpose, the weight of some certain number of seeds, or of a single seed, not liable to variation, has been usually chosen. Latterly, the length, or a portion of the length of a cylindrical pendulum that vibrates a certain period of mean solar time, or of a small portion of the earth's circumference, has been proposed to form the side of a cubical vessel to be filled with water, and the weight of this water to form the standard. Of the mensuration of the circumference of the earth to make a standard for weight it is needless to speak, since it is mere philosophical quackery; the pendulum that vibrates seconds of time in the capital of each state, is a more manageable mean, and is very fit to form the basis of an inquiry into the actual standards of weights and measures of any country, and to communicate the result to foreign nations in a manner intelligible to scientific men, however Butler may have attempted to ridicule the idea in his Hudibras, part ii. canto 3, line 1019. To enable, however, ordinary persons to verify their own weights, or those of their neighbours, the mode proposed by our old lawgivers, and improved upon by Tippoo Sultan, is the only one that can be adopted; as seeds are easily procurable by all, and do not require the expense either of a recurrence to the authentic standards, which in the Exchequer amounts to 36*s.* 4*d.* for the officer's permission, and 2*s.* 6*d.* to the yeoman for sizing them, or of the construction of a delicate apparatus to verify a set of weights and measures. If we may judge from the present standards, which are evidently inaccurate, since the parts do not agree with the whole, nor the different standards of the same name agree with one another, seeds are less variable than them. The numerical weight of seeds being less affected than might be supposed from their apparent difference of bulk, or even their different weight by the bushel, and the variation from soil or other causes may be in great measure avoided by Tippoo's method of taking the average of nine different kinds of seeds. Diamonds and other jewels, the most valuable articles known in commerce, are weighed by the seeds of the kurua tree, in preference to artificial weights.

From a careful examination of the standards in the Exchequer it has been found, that a pendulum which would in London on the level of the sea vibrate in a vacuum seconds of mean solar time, measures 39·13 inches of the standard yard of 36 inches, a copy of that constructed originally by taking the length of three barley corns for an inch. 2ndly. That a cubic inch of distilled water, at 62 deg. Fahr. weighs in a vacuum 252·722 grains Troy; or at 39 deg. at which temperature water is at the maximum of density, 253 gr. but in the open air, under the common circumstances of the atmosphere and counterpoised with brass weights, 252·456 grains; the grains being originally constructed by assuming the old penny piece of silver weighing 32 grains of red wheat taken from the middle of the ear, to weigh 24 grains Troy.

Avoirdupois, or Roman Weight.—The commonest weight in use, and therefore, without doubt, the most ancient, is that called at present avoirdupois, but which seems to have been formerly denoted by the name of auncel weight, from its being weighed, according to the Roman usage, by the statera Romana or stilliard, or by the auncel, ansula, or Danish stilliard, with a fixed weight and moveable fulcrum. It seems to have been introduced by the Romans at the first civilization of this island, and although kept up chiefly by the stilliard, has descended so accurately to our time that the 12 oz. pound varies only 11 gr. Troy from the standard still kept at Rome. The word haberdepois is first used in our laws in 1303, 31 Edw. I. but as a class of merchandizes including wine as well as corn. In 27 Edw. III. wools, and all manner of averdepois, were ordered to be weighed by even balance, and not by the auncel. In 1533, 24 Hen. VIII. the name first occurs as applied to this weight, butchers being ordered to provide beams, scales, and weights, called haberdepois; and Elizabeth, in 1586, caused the present weights in the Exchequer to be made, from those preserved in the hall of the Founders company, and by her prerogative proclaimed them to be standards; the weight, however, has never yet received any parliamentary sanction, but has continued in use in spite of the Saxon and Danish conquests, and the attempts repeatedly made to establish the Norman Troy weight in its place.

The avoirdupois weight is thus divided, and to its several divisions are affixed their value in grains Troy.

						Equivalent weight in grains Troy.
1 grain English						0·77
24 =	1 scruple English					18·22
36 =	1½ =	1 adarme of silk				27·34
72 =	3 =	2 =	1 dram English			54 69
576 =	24 =	16 =	8 =	1 ounce		437·50
6912 =	288 =	192 =	96 =	12 =	1 small pound	5250·00
9216 =	384 =	256 =	128 =	16 =	1 pound	7000·00

Other pounds containing more ounces are in use in different places and trades, as that of raw silk, which contains 24 oz. but the common lb. is used to weigh the articles, and the weight is then reduced. In like manner the Roman government allowed the merchants for waste, in paying custom duties, 20 oz. to the lb.; so that the 100 lb. or centenarius was 120 common lb. It then lowered the allowance to 18 oz. to the lb.; so that the 100 lb. was 112 com. lb. and an half. The fraction is now omitted, and only 112 lb. is allowed, the 100lb. of 20 oz. to the lb. is still in use in some parts of the country, or in particular trades.

The Saxon and Norman conquerors having introduced their native weights into our mints, this procedure obliged the gold and silver smiths to adopt the same, and the apothecaries, who are the only other tradesmen that use small weights, being incurious about them, from not having the same check as other dealers in their customers reweighing the articles, took up with those they found in the scale makers' shops for weighing coin; and thus the drams, scruples, and grains, of the avoirdupois weight are gone out of use; so much so, indeed, that the dram, scruple, and grain English, are now adjusted to the Troy ounce, and differ only from the dram and scruple apothecary, and the grain Troy, by having their value marked upon them in words at length, instead of the medical characters of the two former, or the dots of the last. Silk is now the only article sold by less than the quarter of an ounce avoirdupois, and is sold by what should be called the adarme, a Spanish weight probably imported along with the article itself, and which is, in the common treatises on arithmetic, confounded with the dram, the school masters dividing the ounce into 16 drams instead of adarmes; and, of late omitting the mention of the drams, scruples, and grains English.

Although we have retained the Roman weight, we have considerably shortened the nomenclature of it, which was rather complicated; but as this nomenclature is used in Latin medical and chemical books, which are accurately written, it should be known to medical students. The sixteen oz. pound seems to have been called by the German name pondo, or the Greek mina; the 12 oz. libra or assipondium, and for every particular number of ounces they used a peculiar name, as, for 11 oz. they said deunx;—for 10, dextans or decunx;—for 9, dodrans;—for 8, bes, bessis, or des;—for 7, septunx;—for 6, semis, semissis, semissius, selibra, or sembella;—for 5, quincunx;—for 4, triens;—for 3, quadrans libræ, or triunx;—for 2, sextans libræ; and for 1 oz. simply uncia.

The common traders seem to have divided the ounce by the powers of two, into semiunciæ, sicilici, &c.; thus,

	Equivalent weight in Troy grains.
1 lens or primus	0·76
18= 1 quadrans drachmæ	13·64
36= 2= 1 dimidium drachmæ	27·28
72= 4= 2= 1 drachma	54·57
144= 8= 4= 2= 1 sicilicus, or siclus	109·14
288= 16= 8= 4= 2= 1 semiuncia or assarius	218·29
576= 32= 16= 8= 4= 2= 1 uncia	436·58
6912=364=192= 96=48=24=12=1 libra	5239·00
9216=712=256=128=64=32=16=1 mina or pondo	6985·00

Another division of the ounce in common use with medical writers is into sextulæ and scrupuli; which latter were subdivided in imitation of the Attic weights.

	Equivalent weight in Troy grains.
1 chalcos	1·13
8= 1 simplium, or obolus	9·09
16= 2= 1 scrupulum, or gramma	18·19
64= 8= 4= 1 sextula or sextans	72·78
128= 16= 8= 2= 1 duella or bina sextula	145·56
384= 48= 24= 6= 3= 1 uncia	436·58
4608=576=288=72=36=12=1 libra	5239·00

The moneyers, and of course the assayers and metallurgic chemists, divided the ounce into denarii, libellæ, &c. and some of these divisions were taken, by particular dispensers of medicine, as nearer imitations of the Attic weights, ordered by the physicians, than the former.

	Equivalent weight in Troy grains.
1 sextans libellæ, taken for the Attic chalcos	1·04
$1\frac{1}{2}$= 1 quadrans libellæ, or teruntius	1·56
6 = 4 = 1 libella, as, or assarion	6·25
10 = $6\frac{2}{3}$= $1\frac{2}{3}$= 1 sextans denarii, or Attic obolus	10·42
15 = 10 = $2\frac{1}{2}$= $1\frac{1}{2}$= 1 quadrans denarii, or sestertius	15·62
60 = 40 = 10 = 6 = 4= 1 denarius, or Attic drachma	62·51
420 = 280 = 70 = 42 = 28= 7= 1 uncia	436·58
3360 =2240 =560 =336 =224=56= 8=1 bes, or des	3500·68
5040 =3360 =840 =504 =336=84=12=1 libra, or as	5239·00

Tower, or Saxon Weight.—The next weight introduced by our ancestors, and which is still retained in use, is that known by the name of the Tower pound. From an old record it appears, that this pound counterpoised 11 oz. 1 qr. Troy, or 5400 grains. The exact correspondence of 8 ounces of this weight with the mark of Cologne, used in most of the German mints, shows that this pound is evidently the small pound of our Saxon ancestors, or that of the Easterlings, as being derived from Greece, through Thrace. Galen informs us, that 24 Greek litras were equal to 25 Roman libras, which is very nearly the proportion between this pound and the 12 ounce avoirdupois pound.

The reports of assayers refer to this small Saxon pound as the integer; that used in assaying gold, and formerly in weighing it, by pounds and mancuses, is thus divided: to which is added, the counterpoise in Troy weight:

	Equivalent weight in Troy grains.
1 Tower grain	0·98
15= 1 quarter carath grain, or feorthling mancus	13·87
60= 4= 1 carath grain, or mancus	55·50
240= 16= 4= 1 carath, or loth	225·00
5460=384=96=24=1 Tower pound	5400·00

The subdivision of this weight by 4 and 4 shows to what nation it belongs, especially as all our neighbours on the Continent divide the carath differently; some as the French into 32 thirty seconds; others, as most of the German mints, into 12 grains, and these into 4 small grains. Analogy, then, leads us to infer, that the integral pound used in assaying silver refers to this weight, although being divided the same as the Troy, the integer is now supposed to refer to the pound of that weight; and the talent, now called a journey (day's work), of silver is taken as 60 lb. Troy.

	Equivalent weight in Troy grains.
1 Tower grain	0·98
24= 1 peninga, or penny	22·50
480= 20= 1 ora, or ounce	450·00
5460=240=12=1 Tower pound	5400·00

These modes of division have survived to our time. Our ancestors not only divided this pound in other manners for ordinary use, but had also another pound, in more common usage, of 15 oz. like one of the Greek pounds; and moreover a Danish mark:

									Equivalent weight in Troy grains.
1								Tower grain	0·98
24 =	1							peninga	22·50
36 =	1¼ =	1						mærra peninga, or bener peninga	27·75
60 =	2½ =	2 =	1					mancus, or drachma	55·50
96 =	4 =	3⅗ =	1⅗ =	1				smaelle skylling	90·00
120 =	5 =	4 =	2 =	1¼ =	1			skylling	112·50
384 =	16 =	12⅘ =	6⅖ =	4 =	3⅕ =	1		smaelle ora	360·00
480 =	20 =	16 =	8 =	5 =	4 =	1¼ =	1	ora	450·00
2400 =	100 =	80 =	40 =	25 =	20 =	6 =	5 =	1 Danish marc	2250·00
5460 =	240 =	192 =	96 =	60 =	48 =	15 =	12 =	1 smaelle punda	5400·00
7200 =	300 =	240 =	120 =	75 =	60 =	18¾ =	15 =	1 punda	6750·00

Both the pounds were therefore divided alike into 15 ores, that is, ounces; the ores into 4 skyllings, the sicilici of the Romans, and the skyllings into 4 pence by the Saxons, while the Danes used the mark of 20 skyllings, and the skylling of 2 mancuses. As to the thrimsa and scaetta, they appear to be the skylling and penny of silver in a coined state, and hence their variable reduction to other sums rated in bullion, from the variations in the state of the coinage, for which a greater or less allowance was made.

Many commodities, after being weighed by the hundred weight and reduced to common lbs. have, in London, a decrement called trett taken off, namely, 4 lb. in 104 lb.; now this singular allowance is the difference between the Tower and avoirdupois lb.; 104 Tower lb. of 15 ores being equal to 100 avoirdupois lb. of 16 ounces. Hence it should seem, that when this decrement was first allowed, the Tower weight was used by the Custom house and tackle porters of London, and that this decrement was taken off, for the purpose of reducing the weight to the Roman or avoirdupois weight used in the inland trade; but has since been continued, from habit, restricted to articles having waste, and its origin has been confounded by school masters unversed in real business with that of cloff and draught.

Troy, or Norman Weight.—The arrival of the Normans from France, brought in another weight now called Troy, the ounce of which is much heavier than that of either of the preceding, and hence seems to have given occasion to constant disputes between the Norman and English, and continual complaints of the English dealers using short weight; the falsity of which is evident from the accuracy with which the Roman avoirdupois has descended to us by mere customary usage. Indeed the general interest of society, and the individual honour of the scale makers, would alike resist an universal shortness of weight. This can only be adopted occasionally by a cheating tradesman endeavouring to get more profit than his neighbours by altering his weights after they come out of the manufacturer's hands.

In 1225, it was made one of the provisions of magna charta, that there should be only one weight, one measure, and one quarter of corn in the realm. By this weight the Norman lords unquestionably understood the French Troy weight, to which they and their agents were accustomed, though the people, no doubt, considered the avoirdupois to be that entitled to this distinction. In 1267, 51 Henry III. the first positive attempt was made to change the common weight into the Troy, under the name of the weight of assize, and twenty of the silver pennies then current, being in good condition so as to counterpoise 32 grains of good wheat, were declared to be an ounce; from whence the other terms were thus deduced:

	Equivalent weight in avoird. oz.
1 grain Troy	0·0022
6 = 1 *farthing penny of silver*	0·0137
20 = 1 scruple apothecary	0·0457
24 = $1\frac{1}{5}$ = 1 penny or denarius	0·0548
30 = $1\frac{1}{2}$ = $1\frac{1}{4}$ = 1 *farthing penny of gold*	0·0685
60 = 3 = $2\frac{1}{2}$ = 1 dram apothecary	0·1371
288 = $14\frac{2}{5}$ = 12 = $4\frac{2}{3}$ = 1 shilling, or solidus	0·6580
480 = 24 = 20 = 8 = $1\frac{2}{3}$ = 1 ounce Troy	1·0968
3840 = 192 = 160 = 64 = $13\frac{1}{3}$ = 8 = 1 French mark	8·7744
5760 = 288 = 240 = 96 = 20 = 12 = 1 pound Troy	13·1616

For the sake of calculation, the gold and silver smiths divide the grain Troy into 20 mites, the mite into 24 droites, the droit into 20 periots, and the periot into 24 blanks; which are employed like the parts, seconds, and thirds, used in the calculation of superficial and solid measure by cross multiplication.

As long as the pound of accounts was equal to the pound weight of silver, the shilling was more usually employed as the first division of the Troy lb. than the oz., which seems to have been restricted to the avoirdupois weight, as the name of ore was to the first divisions of the Saxon pound or Danish mark. When, however, the Sovereign, to pay his debts or supply present exigencies, adopted the ruinous expedient of heightening the value of the coin above its real weight, to make the money in his treasury go, for the moment, farther than it otherwise would, unmindful of the consequent diminution of his fixed annual revenue, the shilling was used to express, as at present, the first division of the debased money pound, and the ounce for that of the pound in weight.

Several other Acts of Parliament have been since made, at different periods, to abolish the auncel weight, and to substitute this French weight in its place. The name of Troy weight first occurs in 1414, 2 Henry V. but it was not until 1495, 12 Hen. VII. that the assize weight was called Troy.

Nothing can more strikingly show the great difficulty of a government attempting to introduce a new custom upon the people, when neither the interest of the Sovereign in his revenue induces him to insist on its adoption, nor the convenience of the people in their petty every day concerns, leads them to voluntary obedience, than these abortive attempts of the Norman lords to oblige us to use this large ounce. The Sovereign himself disregarded the law in his mint for 300 years, until 1504, and is supposed then only to have adopted it to assimilate our coins to the Flemish, and thus facilitate the intercursus magnus, or grand treaty of commerce, entered into the year before with the Flemings, against the Hanse towns, which opened the foreign trade to our own capitalists, and enabled Elizabeth, some years afterwards, to expel the Hanse merchants, who were then the commercial tyrants of Europe, from the realm. The Sovereign, even now, disregards the law in the post office, customs, excise, and other offices of his revenue and household. And as to the people, although nearly 600 years are elapsed since the attempt began to be made, the gold and silver smiths, connected as they are with the mint, are the only persons who pay entire obedience; for as to that of the apothecaries, it is but partial. It was probably some feeling of respect for the nation, or a desire of popularity, that induced Elizabeth to have the avoirdupois standards in the Exchequer made by her prerogative; but these weights have never received the sanction of Parliament; and the attempt to oblige the English people to use this French weight, instead of the national weight, is not yet relinquished.

When the London College of Physicians published, in

1618, their first pharmacopœia, Sir Theodore Turquet de la Mayerne, who compiled the work, being a French physician, unacquainted, as it should seem, with the usage of England, and not aware or regardless of the practical inconvenience of apothecaries buying and selling by one weight and making up their articles by another, ordered them to dispense their medicines by the Troy weight, instead of the avoirdupois, by which they buy and sell, and which had been previously used in dispensing. In order to avoid the expense of both piles, or the trouble of calculating how many oz. of one pile are equal to so many of the other, a strange mixture of the two are used. When medicines are ordered in quantities less than a quarter of an ounce, it is presumed that they are powerful in their action, and they weigh them by the Troy weight; but those ordered in a large proportion, being thought to be weak, or intended to be divided into numerous doses, the apothecaries presume that the difference between the two weights will not be of any consequence, and weigh them by the avoirdupois, which they are obliged to keep for their retail business as low as the qr. oz. Thus a trade in which the utmost precision in weights is usually expected, is actually that which is the most inaccurate in that respect; but—the patients have no means of checking errors in dispensing. Some few apothecaries and other dispensers have Troy weights as far as 4 or 8 oz. but scarce any have them heavier. The physicians, who from want of an academical education, or any other cause, practise their profession under the mask of being apothecaries, that is to say, mere sellers of medicine, are at least as inaccurate; and many of them exhibit their medicines by the eye alone, without weighing. Dr. Powell, in his translation of the last pharmacopœia, has desired, in a half-official manner, that no avoirdupois weights should be kept in an apothecary's shop; but that, like the gold and silver smiths, they should buy and sell, as well as dispense, by the Troy weight. He does not consider, that gold and silver are articles bought and sold by that weight, whatever may be the quantity; whereas, the medicines of the apothecary are, in general, only a specific appropriation of articles far more commonly used for other purposes; hence he must buy them by the usual commercial weight, and to forbid him the keeping of that pile in his shop, would deprive him of the power of checking the weight of the drugs sent in by his druggist, who, in the event of any dispute, would not rely on the reduction that might be made by the apothecary of one weight into another. On the other hand, to oblige him to sell by a weight the ounce of which is much heavier than the common, would necessitate the asking of a higher price, by 10 per cent. than the druggist, or a diminution of the profit to the same amount. All this confusion and inaccuracy has arisen from the national vanity of Sir Theodore Mayerne, which led him to suppose that the weight of Troyes in Champagne, must be superior to that of the *barbares* of England; and his ignorance, that those English weights that he despised, were the very weights used by the Greeks and Romans in composing those prescriptions that he selected. The only method to get rid of this confusion would be for the College to disclaim this absurd introduction of the French weight, to return to the national weight, and thus restore the use of its small divisions.

Foil Weight.—Besides these weights affecting all, there is another pound, called the lb. foil, which weighs one fifth less than the lb. Troy. It was used to weigh gold and silver wire, foil, and jewels; and its smaller divisions are still used by the jewellers to weigh diamonds, pearls, and precious stones. As the pound is nearly similar in its content to that of Venice, which counterpoises 4656 Troy grains, and the articles for which it is used were formerly imported from thence, it probably came with them; but the ounce was divided into pennies, instead of sextules, as in the original weight.

	Equivalent weight in Troy grains.
1 sixteenth	0·05
16= 1 jeweller's grain	0·80
64= 4 = 1 jeweller's carat	3·20
404= 24 = 6= 1 penny foil	19·20
7680= 480 = 120= 20= 1 ounce foil	384·00
92160=5760 =1440=240=12=1 pound foil	4608·00

The carat of this weight signifies the seed of the kurua tree, whereas the carath of the Tower lb. is an Egyptian word significant of the 24th part of any thing, and is applied in Egypt to the provinces of that land, or the wards of its larger cities, in the same manner as the Latin uncia is used for the 12th part of any integer whatever. As the jewellers mostly deal also in silver and gold, and are therefore obliged to keep the Troy weight, they now use that pile to weigh their jewels, but reckon, of course, 150 carats for an ounce. The sixteenths foil, which are equal to the mites of the gold and silver smiths, are sometimes divided again into quarters, which are the smallest weights used in commerce. Some authors assert the Troy ounce to counterpoise 152 carats 3 grains, and, of course, the carat to be equal to 3·162 gr. Troy.

Foreign Weights.—These four pounds, namely, the avoirdupois, Tower, Troy, and foil, are the only weights used in England; but as the works of the French and German chemists are frequently translated, some knowledge of their weights is necessary.

The French weight in actual use is thus divided:

	Equiv. wt. in grammes.	Equi. wt. in Troy grs.
1 grain	0·530	0·82
7⅕ = 1 *felin*	0·382	5·90
14⅘ = 1 *maille*	0·764	11·81
24 = 1 denier, or scrupule	1·274	19·69
28⅘ = 1⅕ = 1 esterlin	1·529	23·62
72 = 3 = 2½ = 1 gros, or dragme	3·824	59.07
576 = 24 = 20 = 8 = 1 once	30·598	472·56
4608 = 192 = 160 = 64 = 8 = 1 marc de Charlemagne	244·787	3780·54
6912 = 288 = 240 = 96 = 12 = 1 livre, poids de médecine	367·180	5696·75
9216 = 364 = 320 = 128 = 16 = 1 livre, poids de marc	489.574	7561.00

The French philosophers, for parade, have vapoured much of a new weight to be deduced primarily from an admeasurement of a degree of the earth's surface. The initial weight to be called a gramme, from whence the other terms are deduced decimally.

	Gramme.	French grains.	Troy grains.
Myriogramme.. =	10000 =	188224·66 =	154440·23
Chiliogramme.. =	1000 =	18822·46 =	15444·02
Hecatogramme. =	100 =	1882·24 =	1544·40
Decagramme .. =	10 =	188·22 =	154·44
Gramme ...... =	1 =	18·82 =	15·44
Decigramme... =	0·1 =	1·88 =	1·54
Centigramme .. =	0·01 =	0·18 =	0·15
Millegramme .. =	0·001 =	0·018 =	0·015

Although the new chemical books in French nominally use the gramme, yet in all their processes for practical purposes, it will be found that they are mere reductions of the common weight to the decimal scale, so that the new metrical system has only mystified, to use a French term for hoaxing, the students, and produced a similar discrepancy between books and the laboratories, as the new nomenclature has produced, in many instances, between books and the shops. Indeed their government has lately given up the point, and allowed the use of the old pound, ell, &c. only ordering them to be divided decimally, as is done in England with long measures, whenever convenience requires it, without any coercion.

In regard to the German weights, the common pound varies in almost every state, but the chemists generally employ the Cologne mark weight, or the medical pound of Nuremberg, as being in the most general use.

The Cologne mark weight is thus divided:

	Equivalent weight in Troy grains.
1 as, or esche	0·83
8½= 1 *heller*	7·05
17 = 1 pfenning	14·11
68 = 4= 1 quintlein, or dram	56·44
272 = 16= 4= 1 loth	225·76
544 = 32= 8= 2= 1 unzen	451·52
4352 =256= 64=16= 8=1 mark	3612·20
6526 =384= 96=24=12=1 pfund	5418·30
8704 =512=128=32=16=1 mark pfund.	7224·40

In calculations the pfennings are divided into 256 richtpfenning-theilen.

Pharmaceutical writers generally use the medical lb. which is divided into ounces, drams, and scruples, like our own; the ounce being equal to 469 Troy grains.

The Swedish common lb. is equal to 6556 gr. Troy, and is divided into 32 lods, or half ounces of 4 drams each.

Subtle Weights.—For experimental purposes, the pound or other integral weight is taken either by custom or at pleasure. Thus, for assaying silver to discover its fineness, six grains are customarily taken for a Tower pound, which is divided as low as the half penny weight, whose real weight is the 80th part of a grain; so that the fineness of silver is estimated to the 480th part of the mass. For assaying, six grs. Troy are in like manner taken for a Tower pound, and divided as low as the quarter grain, whose real weight is the 64th part of a gr. Troy; for the fineness of gold, although it be about 14 times more valuable than silver, is estimated, in England, only to the 384th part of the mass, but in France, to the 768th, and in Germany to the 1152ndth. Twelve grains are usually sent, originally that two simultaneous experiments might be made, the accordance of which would show that no error was committed; but most English assayers now use the whole in a single trial. For assaying ores a dram is usually taken, and is called an hundred weight, and divided into pounds, ounces, and half ounces; so that, if it be the stannery weight of six score pounds to the cwt. each lb. is represented by half a grain Troy, the ounce by the 32ndth of a grain, and the half ounce by the 64th of a grain. In all these kinds of subtle or assay weights, the artists have setts adjusted with the utmost exactness and stamped with the fictitious value in order to avoid the trouble of calculation. The real weight of the fictitious pounds used by Lavoisier in his experiments was frequently different: he pretends to have divided them decimally to five or six places of figures; but these fractions are certainly the mere result of calculation, and quoted only for parade and deception, as no practicable means exist of determining weights to that minute exactness. He confesses, indeed, c. iii. that in relating experiments, he gives the combined results of several in a single detail, a circumstance which in like manner greatly diminishes their authenticity and value. The English experimental chemists usually employ 100 grs. Troy, each of which they divide into tenths and hundredths; and if 100 grs. cannot be employed in their experiments, they generally calculate the results as they would be if that weight had really been used.

Balances.—Good balances are not only necessary for nice experiments, but also save time in weighing things for common purposes. Those with short beams are strongest and have the quickest angular motion; they should always have a stand or be suspended from the ceiling, and never have any thing that would soil or dirty their pans put therein, without some vessel, or at least paper to defend them. The balances in common use with druggists and apothecaries on the counter, are in general too small, and very inaccurate. For retail trade, the best size is a beam that will carry 20 lb. avoird. an end, and turn readily with 10 grs. Troy when fully loaded, that is, with one 14000th part of the weight in the scale. For dispensing, a beam that will carry eight ounces an end, and when fully loaded turn readily with one 10th of a grain, that is to say the 3840th part of the weight, would be far superior to the common apothecaries' grain scales, whose filthy state is generally a disgrace to their shops. For weighing powders and salts, a watch glass with a brass counterpoise should be kept in readiness. For experimental chemistry on a small scale, beams which are sensible to a very minute weight are requisite; those used by the assay masters turn with less than the 740th part of a grain Troy, but they are seldom so accurate as the larger scales. These assay balances require to be inclosed in a glazed case, the front pane of which will slide up and down, to allow room for putting in the weights and things to be weighed. The adjustment of balances is a work of considerable time, and therefore accurate ones are expensive. The goodness of a balance for commercial purposes requires not only sensibility, but also that the arms be of equal length, so that the beam will remain in equilibrium when the weights and the thing weighed are changed from one scale to the other. This equality of the arms, although desirable, is not absolutely necessary for experimental purposes, provided the balance is sufficiently sensible to a small weight, as the inequality will not affect the proportion of the weights to one another. A balance, although its arms be unequal, may be used occasionally to determine the real weight of a thing, by first counterpoising it with shot, powder tin, or any other body, then taking the thing to be weighed out of the scale, and putting in its place the necessary weights, which will show the proper result, at the expense indeed of some time. By counterpoising two weights and registering the result, the real weight of a body may be determined at any future time by one weighing with a little calculation; for as the weight which in the previous trial was put into the scale A, is to that then counterpoising it in the scale B, so is the weight now in the scale A, to the real weight of the thing in the scale B.

Pile of Weights.—A pile of weights is usually so formed that each weight, except the first, is the half of that next above it: but this is sometimes not the case. Each of the standard suites of weights in the Exchequer consists of two parts, which will serve to show their construction. The bell shaped avoirdupois suite consists of seven pieces: namely, the half cwt. or 56 lb.; the quarter cwt. or 28 lb.; the half quarter cwt. tod, horseman's stone, or 14 lb.; the 16th of a cwt. clove, or 7 lb.; a weight of 4 lb. 2 lb. and 1 lb. in all forming 112 lb. or a whole hundred of five score and twelve.

The other avoirdupois suite is a flat pile of a butcher's stone or 8 lb. weight, one of 4 lb., 2 lb., 1 lb., half a lb., a quarter of a lb., a half quarter lb. or 2 ounces, the 16th of a lb. or 1 ounce, half an ounce, a quarter of an ounce, a half quarter of an ounce, and two 16ths of an ounce, in all forming 16 lb. These two suites cost Elizabeth 6*l.* 0*s.* 10*d.* The Troy suite has first a hollow or cup pile, the outer case of which weighs 256 ounces: then a weight of 128, 64, 32, 16, 8, 4, and 2 ounces; then one of a single ounce, half an ounce, a quarter of an ounce, a half quarter of an ounce, and 2 pieces called farthing gold weights or 16ths of an ounce; in all 14 pieces, weighing together 512 ounces, or 48 lb. 8 ounces. Secondly, an ivory box of small weights: namely, one of an ounce or 20 dwts., half an ounce or 10 dwts., a quarter of an ounce or 5 dwts., one of 4 dwts., 3 dwts., 2 dwts., 1 dwt. or 24 grains, half dwt. or 12 grains, a farthing silver weight or 6 grains, one of 4, 3, and 2 grains, and a single grain; in all 13 pieces. The whole Troy suite cost originally 3*l.* 8*s.* 1*d.* but the ivory box seems to be lost, for Graham says, there are no weights in the Exchequer that are standards for grains. The accuracy of a pile is examined, by counterpoising each weight with so many of the smaller as are necessary; and the goodness of the pile for commercial purposes, is shown by reference to a legal standard pile, or by weighing a determinate number of new coin, and observing whether the weight, as found by the balance, agrees with what it ought to be by calculation.

Subtle Piles.—Experimental chemists usually make their own weights, or at least adjust them; and this is done, either by repeatedly doubling an initial weight, or halving it: in the former method, an error being once committed goes on increasing rapidly, therefore the latter mode is usually fixed upon. The initial weight is first chosen, which, though not absolutely necessary, yet is most convenient when it may be halved several times without requiring a fractional expression, and is of some certain commercial value, as 64 or 128 lb. ounces, or grains. If the latter be chosen, two dishes of copper, glass, or blued steel, are then put into the pans of an equal armed balance, and exactly counterpoised by filing or grinding off on a grindstone or hone that which is the heaviest, until they are rendered exactly of the same weight. In one of these dishes is put the initial weight, and in the other powdered tin, or dry white sand previously well washed, in sufficient quantity to counterpoise it: the final adjustment being made with a parcel of rings of fine silver wire, formed by rolling the wire very close round a piece of thick wire, and then drawing a knife along the fine wire the whole is cut into rings of equal size, the which rings ought to be such that one of them will just sensibly affect the balance when empty. The two dishes are then taken out of the scales, and placed on a very smooth black painted board, situated between the light and the eye. The initial weight is then laid by, and, by means of a spoon and forceps, the tin powder is distributed as equally as possible between the two dishes, observing to put nearly all the adjusting rings into one of the dishes. The dishes being replaced in the pans of the balance, if they be not of equal weight they are taken out again, placed on the black board, and so much as is judged necessary of the tin powder is taken out of the heaviest and placed in the lightest dish. They are then replaced in the balance, and if not equiponderant the process must be repeated until both the dishes are of equal weight: the whole being an excellent trial of the experimenter's patience. The tin powder is then to be taken out of that dish which contains the fewest rings, and a bit of brass or silver of the proper shape, and nearly the same weight, but rather too heavy, is placed in the emptied dish, and by repeated weighings and filings is reduced to the proper weight; the final adjustment being made by rubbing it a stroke or two on a fine hone, as a file might take off too much and entirely spoil the weight. The weight piece thus obtained is to be laid upon the tin powder in the other dish and counterpoised with the initial weight, as a proof of the correctness of the operation, and a means of discovering whether any portion of the tin powder has been lost in spite of every precaution, and of course the whole labour been taken in vain. This being accomplished, the tin powder in the dish is to be divided in like manner into two equal parts as before, and the process of making a weight piece repeated until the smallest weight sensible by that balance is obtained: each weight being examined as it is formed, first with the one immediately preceding it, and secondly the whole sett with the initial weight. For very small weights, jewellers foil, having the colour washed off with warm water and then dried, is a good material. A few peculiar weight pieces of frequent use may be made and kept in readiness, by adding two or more weights together and forming a third from them, as those for 100, 50, 25, 12, 6, and 3 unities of weight, be they of what denomination they may. Some increase by ones up to 10, then by tens up to 100, then by hundreds up to 1000; which, it appears, from the nummulary system of the Romans, was in use with them; and this is a good method: although more expensive at first, it saves time afterwards when several weights come to be added. Some have attempted to shorten the labour of forming a pile of weights, by first counterpoising the initial weight with wire of a proper size, and then, after measuring it carefully, by calculating and cutting off by measure the counterpoises of the intended pile. Although this may do for common purposes, yet when extreme accuracy is required, the other method will have the preference. It is indeed so difficult to assize a suite of weights, that it would seem necessary, in actual business, to allow that if the whole pile taken together is accurate a small discrepancy in the subdivisions should not vitiate the use of it, provided that this remedy, as it is called in the Mint, should not exceed the —— part of the weight in any one piece, nor defect be peculiar to those pieces that are in most frequent use.

Concave Measures.—Of concave measures little need be said, as they are only quick but inaccurate modes of measuring a certain weight of fluids, seeds, powders, or other similar bodies, composed of small discrete particles. Originally in all, and still in many, countries there are as many initial concave measures as there are fluids, seeds, &c. usually sold in the shops and varying in weight in the same bulk, as of wine, honey, oil, wheat, &c. Although seeds, and some other solid bodies, formed of small pieces, are usually measured, yet the observations which have been made of the various weight which the same measure will contain when different modes of measuring are used, are sufficient to show that measuring ought to be confined to fluids only; and even fluids themselves when measured will weigh more or less, not only according to the width of the vessel, but also as the edge of the vessel is wet or dry.

The only natural standard of concave measures that has been proposed is that of the content of the eggs of birds: those of the hen were employed by the Jews. According to Bernard, these eggs hold an ounce and three quarters Troy of water. The statute of 31 Henry III. which first attempted to fix the legal ounce from the weight of a certain number of the silver pennies then current as already related, says that 12 ounces shall make a pound in weight, and 8 pounds weight a gallon of wine, 8 gallons a bushel of wheat, and 8 bushels a quarter. This statute has been differently interpreted: according to some, a vessel that holds 8 pounds Troy of wheat, is a gallon measure; while others think that it means to say, that 8 pounds Troy of any measurable commodity is a gallon, and, of course, that every different commodity ought to have, as formerly, a gallon measure of greater or less size according to its heaviness on the hand; while a third party assign 8 pounds Troy of the wine usually drank at that time, probably claret, as the legal gallon.

None of the ancient standards of concave measures will exactly agree with either of these interpretations of this statute. The smallest standard gallon which comes the nearest, is that kept in the Guild hall in London, and which is supposed to have been made at the time. It measures 224 cubic inches, and of course will hold 7·46 lb. Troy of wheat, at 59 lb. avoird. to the Winchester bushel, which is the mean weight of good corn, but it would certainly hold 8 lb. or even more by packing close. By some mistake, or customary usage not explained, this standard gallon was said to contain 231 cubic inches, and the revenue officers levied the customs on wine by that content. The customary measure of a gallon of corn was, mean while, taken as 272·25 cubic inches, holding 9·77 lb. Troy of wheat, equal to 7·46 lb. avoird. and of course being to the Guild hall gallon very nearly as the avoirdupois pound is to the Troy.

In the reigns of Elizabeth and James the standards in the Exchequer were made: they are as inaccurate as the weights. Bird, in 1758, found on measuring them, that the bushel contained 2124 cubic inches, the gallon 271, the quart 70, and the pint 34·8. Some ancient standards at Havering Bower, the residence of our Saxon kings, vary from these; for the gallon there is more than the Exchequer gallon by three quarters of a gill, and the quart is less than the Exchequer quart by one third of a gill.

In 1661, 12 Charles II. the gallon of malt liquor, by which the excise duties were to be levied, was fixed at 282 cubic inches, and being to the revenue wine gallon as the lb. avoird. is to the lb. Troy. This large gallon was probably allowed for loss on keeping the liquor, by yeast and lees.

The 13 and 14 Will. III. ordered corn to be sold by the Winchester bushel, which was to be 18·5 inches in diameter and 8 inches in depth, so that the gallon is 268·8 cubic inches.

A merchant in the reign of Anne, refusing to pay custom duties upon some wine by the gallon of 231 cubic inches, alleging that no standard of that capacity existed in the Exchequer, an Act was passed declaring a concave cylinder, 7 inches diameter and 6 inches deep, that is to say, 231 cubic inches, to be the legal wine gallon by which the revenue was to be levied; but the standard then made being measured by Bird, holds 231·2 cubic inches.

By a statute 31 Geo. III. 57 lb. avoird. of wheat, 56 of wheat meal, 45 of flour, 49 of barley, 48 of barley flour, 42 of bigg, 41 of bigg flour, 38 of oats, 32 of oat flour, 55 of rye, or 53 of rye flour, are to be taken for a Winchester bushel of these grains or meals respectively.

As if this variety of gallons was not sufficient, two new gallons, one of 277 cubic inches, and another of 280, under the imposing name of the new imperial gallon, have been lately proposed by speculative philosophers, who, from want of practical knowledge, imagine difficulties exist where none are known; each trade being well acquainted with the weights and measures used by themselves, and the diversity of them in different places being an object of complaint only to interloping merchants, who wish to speculate to the prejudice of the regular dealers, whose interest is identical with that of the community at large, in preferring a regular steady price. All that is required is, that, as at Rome, the measure of the standard yard should be cut in a granite block inserted in the wall of the town halls, and that the metallic currency should be coined in ounces, their multiples or submultiples; so that persons may have an easy means of verifying their weights and measures, without paying fees or giving trouble to their neighbours in office.

The gallon, whatever may be its content, is thus divided by retailers:

Quarter gills.					
4 =	1 gill.				
16 =	4 =	1 pint.			
32 =	8 =	2 =	1 quart.		
64 =	16 =	4 =	2 =	1 pottle.	
128 =	32 =	8 =	4 =	2 =	1 gallon.

These are the usual commercial measures; but the market gardeners about London are exempted from the necessity of using the Winchester bushel, and allowed to use their own customary measures, bearing the Hindostanee names of maunds and seers, or, as they corruptly call them, sieves; but the contents do not now correspond with those used in India.

Medical Measures.—The medical faculty requiring smaller measures than the quarter gill, the College of Physicians have ordered the apothecaries to use the wine gallon of 231 cubic inches, and to divide it thus:

	Content in cub. in.	Content of water in Troy grs.
1 minimum	0·003	0·949
60= 1 fluidrachma	0·2	56·950
480= 8= 1 fluiduncia	1·8	455·604
7680= 128= 16=1 octarius, or pint	28·8	7289·667
61440=1024=128=8=1 congius, or gallon	231·0	58317·336

Besides these fixed measures, medical men, in communicating with their patients, order the medicines to be taken by wine glasses or cups, estimated at an ounce and an half; table spoonfuls, which in syrups is estimated at half an ounce, and in distilled waters at three drams; or tea spoonfuls estimated at a dram.

The ancient physicians and chemists generally used, according to Pliny, lib. 22, cap. 33, the Attic dram as the initial measure, 10 of which made the cyathus, 15 the acetabulum, and 60 the hemina; but, according to Nicolaus, the author of the oldest dispensatory we have, the medical sextary or cotula is said to have held 30 ounces, and the hemina to be the half of the sextary, or 15 ounces; hence, this latter hemina was nearly double that quoted by Pliny. Thus there was a difference between these two measures of the same name, somewhat similar to that between the English pint and that used in Scotland and France, one of the latter being equal to two of the former.

Chemical Measures.—For philosophical purposes, chemists measure fluids either by cubic inches, ounce measures equal to the bulk of a Troy ounce of water, grain measures of water, or grain measures of quick silver: the relative contents of which are as follows:

	Cubic inches.	Content of water in gr. Troy.
Ounce measures .... =	1·00528 =	480
Cubic inches .... =	1·00000 =	252·456
Grain measures of water .... =	0·0039710 =	1·000
Grain measures of quick silver =	0·000294 =	0·740

These medical and philosophical measures were formerly made of horn but now of glass, and are graduated by weighing a quantity of water or quick silver equivalent to the smallest quantity they are intended to indicate, then pouring it into the measure and placing it on a level surface, at the same height as the observer's eye, with a light beyond it, a mark is made with a writing diamond or file on the side next the observer, and also on that opposite to him. Fresh quantities of water or quick silver are then added, and their surface marked on the sides until the measure is nearly filled. Instead of the inverted conical form in which these graduated measures are now usually made, they should be cylindrical, and as narrow as may conveniently be.

Assay Tubes.—In imitation of the subtle or imaginary pounds of assayers, glass tubes are frequently divided, without any regard to their content in reference to a legal or philosophical standard measure. A glass tube, previously weighed, is filled as high as is convenient with quick silver, and the weight of that metal in grains ascertained: a little is then either added or taken out, so as to render the weight of that in the tube divisible by the required number of divisions without leaving fractions of grains in the quotient. The quick silver is then poured out; and by returning it in successive portions into the tube, this is graduated. To avoid the trouble of weighing, a slender glass tube may be drawn to a fine open point at each end, and this being dipped into quick silver, and then the upper opening closed by the finger, may be used as an initial measure. If the tube is to be divided into 100 parts, it may be first divided into tenths, these marked very distinctly with a fine file previously wetted to diminish the vibration, and numbered from the closed end on one side, and from the open end on the other: and afterwards, each tenth may be subdivided, and marked in a slighter manner. These kinds of tubes are variously denominated from their use, as eudiometers, alkalimeters, lactometers, indigometers, blanchimeters, &c.; but that of assay tubes, or subtle measures, will include every variety. The usual and most convenient number of divisions are 8, 12, 40, 64, or 100.

Foreign Measures.—A slight mention of foreign concave measures is sufficient, because chemical writers generally mention the weight of water that those they use will hold.

In French processes there is frequently mentioned the seau or pail, and the Paris pint similar to our English quart. As to the Saint Denis pint, which is double the Paris pint, and of course similar to our pottle, it seems to be customarily used in our English green-glass houses in quoting the sizes of retorts; perhaps the first blowers of them were workmen brought from the glass houses of that town.

The Swedish chemists use the can (kanne), measuring 100 cubic inches of that country, very nearly equal to 190 cubic inches of our measure, and holding as nearly 100 Troy ounces of water, or rather more than six pints and an half English.

Specific Gravity.—The same measure or bulk of different bodies varies in weight, as an Exchequer standard pint of water weighs 20 oz. av. but if the same measure of quick silver were taken, it would weigh about 272 oz. or 13·6 times the weight of the water. The difference between bodies in this respect is called their density or specific gravity, and for the sake of ready comparison is usually referred to a common medium; distilled water, at a determinate temperature, which if stated as 1000, at 56·5 Fahr. and under the atmospheric pressure of 29·76 in. will have this further convenience, that the numbers expressing the specific gravity of the different substances will at the same time show the av. ounces that a cubic foot of them would weigh.

The specific gravity of dense fluids is easily ascertained by finding how much water a bottle with a narrow neck filled to a certain mark will contain by weight, and then when filled with the fluid to be examined; for, as the weight of the water is to the weight of the other fluid, so is 1000 to the specific gravity of the fluid; and, of course, according to the rule of three, as the doctrine of proportion is vulgarly called, by multiplying the second and third terms, and dividing the product by the first term, the fourth or specific gravity is obtained. For practical purposes, the comparison of the weight of a certain measure of the liquid in avoirdupois ounces and its fractions, would be preferable to most persons; for obtaining which say, as the weight of water the bottle holds, is to the weight of the other fluid, so is 16 ounces to the weight of a similar measure of the fluid in ounces and parts. In accurate experiments, the temperature must be either brought to the required degree, or a correction made for it, by observing the rate of expansion or contraction by the alteration of temperature. And when volatile fluids are examined, or accuracy required, a stoppered bottle, the stopper having a hole drilled through it, or a fine groove on the side, must be used, that any superfluous fluid may ooze out, and be carefully wiped off.

The specific gravity of solids may in some cases be determined, by forming them into a regular shape, accurately measuring them, calculating the cubic inches they contain, then weighing them, and comparing the weight of a cubic inch with that of water, as formerly stated. If they cannot be reduced to a regular form, their specific gravity may be found by first weighing the specimen under examination, then taking a wide mouth stoppered bottle of a sufficient size to contain the specimen, and weighing this bottle, both empty and with the specimen under examination in it, then filling it up with water, again weighing it, and lastly taking out the specimen and filling the bottle with water, again weighing it. From these five weights, or four, as the first may be easily found by subtracting the 2nd from the 3rd, or the 3rd by adding the 1st and 2nd, the specific gravity is soon ascertained. The difference between the 3rd and 4th shows the weight of water not displaced by the solid; the 2nd subtracted from the 5th shows the weight of water that the vessel holds; hence the difference of these two weights exhibits the weight of water displaced by the specimen. Having obtained this weight, the comparison of it with the weight of the body, will show the specific gravity; or if the weight of water displaced be divided by the weight of a cubic inch, or the like, of water, the cubic measurement of the specimen will be obtained. The specific gravity of most bodies, whether solid or fluid, may be thus obtained, with no other apparatus than the common balances and a bottle: but this statical method requires so many weighings, that the hydrostatical method is generally preferred; which requires only two weighings, and is founded on the following principle:

Bodies immersed in a fluid are buoyed up by it, by a force equal to the weight of an equal bulk of the fluid, as is evident, if it be considered, that if the body was of the same weight, bulk for bulk, with the fluid, it would remain at rest, without any tendency to rise or descend; but the action of the surrounding fluid will be the same, whatever may be the weight of the body, and support an equal weight in all cases: hence a body immersed in a fluid loses as much of its weight as is equal to that of an equal bulk of the fluid.

It is on account of this buoyancy, that a cubic inch of water has been stated above to weigh, as all other bodies do, less in the open air than they would in a vacuum free from gravitating matter; both the water and the brass weights counterpoising it, being buoyed up in the air, each by a force equal to the weight of an equal bulk of that fluid. As the weight of air is only one 834th part the weight of an equal bulk of water, the cubic inch of water has of course a buoyancy of 0·302 gr.; and the brass weights, being 8·5 times as heavy as an equal bulk of water, the weight of the air equivalent to their bulk is only one 7089th part of their weight, so that they have a similar buoyancy of ·035 gr. The difference of these two buoyancies, namely ·267, or rather more than a quarter of a grain, is therefore to be added to the weight of the water in the air, to exhibit its weight in a vacuum.

If some brass be put into the scales of a balance, counterpoised with brass weights in the other, and then dipped into a trough of water, the balance will still remain in equilibrium, because the buoyancy, although altered in absolute weight, is changed equally in both. But if a piece of gold coin is counterpoised against brass weights, and the scales dipped in water, the equilibrium is immediately destroyed, as the gold being 19·3 times as heavy as water, loses less than half the weight lost by the brass, which is only 8·5 times as heavy, and is of course so much the more bulky.

From this buoyant power of fluids, the specific gravity and dimensions of a solid may be found, by weighing it first in air, and then in a fluid of known specific gravity. The following are the most usual practical applications of the hydrostatical principles.

To determine the specific gravity of a solid in comparison with water, and its bulk or volume, it is weighed first in air, as usual, then being suspended by a piece of horse hair to one of the scales, at some little distance, a jar of water, of the proper temperature, is brought under it, and it is sunk therein, the adherent air it carries down with it carefully brushed off and got rid of, an operation of no small difficulty, and it is again weighed. So much horse hair as appears equivalent to that above the surface of the water, is to be previously put into the scale with the weights, for in common experiments, as horse hair is very nearly equal in specific gravity to water, that beneath the fluid is esteemed to have no action on the balance; but in delicate researches, metallic wire is to be employed, and the proper correction made for it, and if the water and body examined are not of the desired temperature, other corrections for the expansion or contraction thus produced are necessary. The difference of weight in air and in water, shows how much water was displaced, or in other words its bulk, and this, if taken in Troy gr. and divided by the weight of a cubic inch of water, namely 252·456 gr. shows the dimensions of the body in cubic inches. The weight in air, divided by that of the water displaced, that is, its bulk, shows the specific gravity in relation to water.

A piece of marble weighed in air 1169 gr. Troy, and when suspended in water only 738; hence it lost 431 gr. which showed that its bulk or volume was equal to so much water. Then dividing its weight 1169, by its bulk 431, the quotient showed its specific gravity in reference to water, taken as unity, namely 2·712; and, of course, by multiplying by 1000, which is only moving the point three figures to the right, it will show the weight of a cubic foot in avoird. ounces, namely 2712. When wood and other bodies, which would float on water, are to be weighed, they must have some heavy body attached to them to sink them, and the necessary corrections made. Thus, a cubic piece of oak, each side being one inch in length, weighed in air 192·5 gr., and had a piece of lead attached to it weighing half an oz. or 240 gr.; of course the whole weighed in air 433·5 gr., and in water 162 gr., so that the two together were equivalent in bulk to 271·5 gr. of water; now the lead itself weighed in water 220 gr. so that its bulk was equal to 20 gr. of water, which being deducted from the total bulk left 251·5 gr. of water for the bulk of the oak, by which its weight 192·5 being divided, gives 0·765 for its specific gravity to water, taken as 1.—When powders are to be weighed, they may be put into a small bucket, and suspended in the water, and liquids may be enclosed in a small bottle, making the necessary corrections. When bodies soluble in water, are to be examined, oil of turpentine, whose specific gravity is to be previously determined, may be used, instead of water, and the results reduced to the standard of water, by this proportion: as the specific gravity of the oil is to that of water, taken either as 1 or 1000, so is the specific gravity of the body in respect to oil, to that usually stated in relation to water.

In like manner the specific gravity of a fluid may be found, by observing the buoyancy of any body in it, and comparing it with the buoyancy of the same body in water. For this purpose a convenient solid, which may be either a glass bubble for light fluids, or a knob of glass or rock crystal for heavy fluids, is to be weighed in air and in water, and then in the fluid to be tried; when the weight lost in the water is to the weight lost in the other fluid, as 1, or 1000, the standard used for water, to the proportional specific gravity of the other fluid.

In these determinations of specific gravity, the bodies must be brought to an uniform temperature, usually with us 60 deg. Fahr.; and when extreme accuracy is required, an uniform pressure of the atmosphere, or a correction, must be made, according to the expansion of the bodies concerned and their relative degree of buoyancy.

Sometimes a reverse of this problem is required: the weight and specific gravity being given to find the bulk; which is obtained by dividing the first by the second. Or, if the bulk and specific gravity be given, their product will give the weight.

Hydrometer.—A solid body specifically lighter than a fluid sinks in it, until the part beneath the surface of the fluid displaces a quantity of the fluid equal to the weight of the solid, and of course it will sink deeper in a lighter fluid than in one that is denser. If, therefore, a solid body be so constructed, as to show with accuracy the depth to which it sinks, it may be made to exhibit, by inspection, the specific gravity of the fluid upon which it floats. Hydrometers, as these instruments are called, are usually constructed of brass, and composed of a thin hollow ball, of the shape and size of an egg, to the top and bottom of which are affixed rods of sufficient length; the upper one is the slenderest and intended for graduation; the lower is thick and short, being only to sink and serve as ballast to the whole: the weight of this part is so adjusted, that the hydrometer may sink to very near the top of the upper stem, when it floats on the lightest liquid intended to be examined by it; while, on the other hand, the upper stem should, if the difference of the specific gravities of the fluids intended to be examined be not very great, be of such length as not to be entirely out of the liquid when it is floating on the heaviest. When the range of specific gravity is great, the length of stem required would be very great, or the graduation must be much confined. The method usually adopted to remedy this, is to add weights to the lower stem, and sometimes on the top of the upper, to increase the weight of the instrument; the first weight being adjusted so as to sink the hydrometer, that floated to the lowest mark of the stem in a fluid of a certain density, up to the highest mark in the same fluid, and so on with each weight in succession. The upper stem is graduated so as to show, by inspection, either the specific gravity of the liquid in relation to water, or the quantity of extraneous matter that, according to experiments, is dissolved in the liquid, as in saccharometers for determining the increase of weight in every barrel, of 36 gallons, of water, by malt being infused therein.

A very ingenious application of the hydrometer was made by Nicholson, by which it supplied the use of a common balance in weighing substances. The ball is now made cylindrical, either of copper, tinned plate, or only a glass phial, corked and waxed, with a wire netted round it. On the top of the upper stem is affixed a cup, and to the lower stem is hung another cup. The instrument is so adjusted as to sink in water to a mark drawn round the upper stem, when a determinate weight, suppose 400 gr., is placed in the upper cup. If the weights are taken out, and any substance of less weight is placed in their room, the instrument requires an addition, suppose of 100 grains, to sink it to the mark; the difference, 300 grains, is then the weight of the body under examination. But if the specific gravity was required, the substance is to be taken out of the upper cup, and placed in that hanging to the lower stem, and the instrument sunk to the mark by putting weights in the upper cup. Let these be 150 gr. then the substance weighs in water 250 gr., which subtracted from its weight in air 300, the difference 50 gr. is the weight of the water displaced; then, as the weight of water displaced is to the weight of the substance in air, so is the specific gravity of water to that of the substance; whence dividing the weight 300 gr. by 50, the quotient 6, shows the specific gravity of the substance in relation to water as unity.

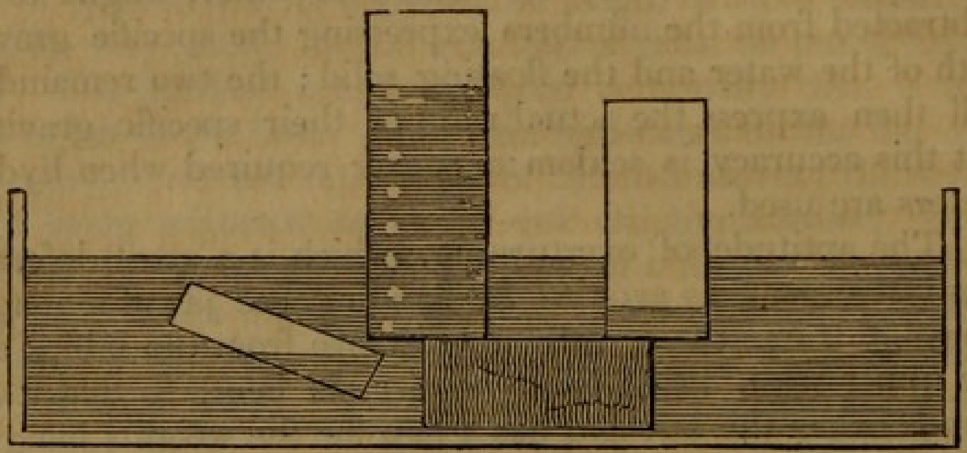
In accurate experiments it must be observed, that a body floating on water, ought to be considered as floating between two immiscible fluids, and therefore the specific gravity of the superincumbent air, in relation to water, ought to be subtracted from the numbers expressing the specific gravity both of the water and the floating solid; the two remainders will then express the actual ratio of their specific gravity: but this accuracy is seldom or never required when hydrometers are used.

The aptitude of overturning, which is a great defect in this instrument, is avoided by hanging the jar of water, in which it is immersed, at some distance from the table, and the upper stem, being made of wire, is bent, so that it descends below the jar, and has a cup for the weights hanging to it directly under the vertical axis of the ball: the centre of gravity being thus depressed, the instrument no longer overturns.

In examining the specific gravity of liquids, they may be used to float the ball, and the different weights required to sink the instruments to its mark, will exhibit their relative specific gravity; the heavier fluids buoying up the ball most forcibly, and therefore requiring the greatest weight to sink it. If the improved construction be employed for this purpose, the strongest acids may be examined, by using a glass bubble with a narrow neck, marked near its top, into which the bent wire may be inserted, and sealed at the lamp.

Gases.—Common air and those liquids that resemble it, require peculiar manipulation to collect and transfer them from one vessel to another; their extreme lightness, however, furnishes an easy manner of effecting this. A trough of water, with some bricks in it, is the principal necessary. On plunging a glass jar or bottle, mouth downwards, into the water, the air contained within it prevents the entrance of the water. If another jar or bottle be plunged into the water, and turned on its side, the air escapes in large bubbles and the water enters the jar or bottle, which may then be raised up an end, keeping the mouth downwards, till the mouth is near the surface of the water, without the water falling, it being retained by the pressure of the atmosphere.

To transfer the air in the first jar into the second, the latter may be brought so as to have the mouth overhang a little one of the bricks in the trough, and the first being then brought close to it, is gradually inclined, when the air will pass in bubbles into the second jar, displacing the water as it enters.



If the mouth of the second jar or bottle is narrow, a shallow funnel may be inserted into it; this funnel should be of light wood, that its buoyancy may press it against the bottle; as the common funnels would require to be held, that they might not fall to the bottom of the trough. Handsome japanned iron troughs with shelves, to the under surface of which funnels of the same material are soldered, are sold for the use of gentlemen amateurs of chemistry, or show lecturers. As some kinds of air-like fluids are absorbed by water, smaller troughs cut out of stone, with a bank on one side, formed in the solid (as loose bricks, or the like, would float on the metal), are used to contain quick silver, with which jars or tubes being filled and inverted, similar experiments may be made in them on a smaller scale: these stone troughs are placed in a wooden tray, to save any quick silver that may chance to be spilled. The air, or similar fluids produced in chemical experiments, are transferred to the inverted bottles or jars by tubes, whose ends are brought under the mouths of the jars as they stand on the bricks in the trough of water, or on the bank of the quick silver trough.

Measurement of Gases.—These elastic fluids, or gases, as they are also called, are usually measured by narrow jars, graduated like the glass measures for dense fluids, but the numbers begin from the top which is the closed end, instead of the bottom. As the pressure of the atmosphere has considerable effect on these rare and highly elastic fluids, care must be taken when they are measured, to sink the jar so low that the surface of the water, or quick silver, within and without the jar, may be on a level; an operation which will sometimes require the jar to be transferred to a pail, a deep butt, or cistern of water, by putting a saucer under it, that the water remaining in the saucer may prevent the egress of the gas, or ingress of the atmospheric air. If it be required to reduce a bulk of air observed at any peculiar height of the barometer, to what it would be at any other height, then as the desired height is to the observed height, so is the observed bulk to the bulk at the desired height. If the surface of the quick silver within and without the jar cannot, from the want of a sufficient body of quick silver, be brought on a level, the existing distance of the two levels must, supposing the inner surface be the highest, be subtracted from the observed height of the barometer. In jars standing in the water trough, as the atmospheric pressure has 13·6 times as much effect on the water as on the quick silver, the former being so much lighter, the difference of the surfaces must be divided by 13·6 to reduce it to a state fit to be deducted from the observed height of the barometer.

A difference in temperature has also a greater degree of influence on these gases than on dense liquids. It has been found, that in ordinary temperatures, all the kinds of them are expanded one 480th or 0·0020833 of their bulk by an increase of temperature equal to 1 deg. of Fahr. Hence, if the observed measure of the gas be divided by 480, it will show its expansion by one deg. Fahr. and if this quotient be multiplied by the difference between the observed temperature and that assumed as a standard for comparison, which is generally 60 deg. the product must be either added to the observed bulk if the temperature be below the standard, or subtracted if it be above. Thus 100 cub. in. of any elastic fluid, at 50 deg., would occupy 102·08 cub. in. at 60 deg.; for 100 divided by 480 gives 0·208, which multiplied by 10 is 2·08, and this product added to the observed bulk gives the corrected. Or the expansion by one degree, namely 0·0020833, may be multiplied by the difference between the observed and standard temperature, and this again by the observed bulk of the gas, which gives the whole expansion by that difference of temperature, to be either added or subtracted from the observed bulk, as the circumstances shall direct. If it is necessary to make a double correction, one for the atmospheric pressure, the other for temperature, that for pressure is first made, and then that for temperature.

Specific Gravity of Gases.—The specific gravity of elastic fluids is usually referred to that of atmospheric air. and is determined statically by observing the weight of a certain bulk, and comparing it directly with the weight of the same bulk of common air. Their extreme lightness, however, requires several precautions. A glass globe, into which a stop cock is inserted, being carefully weighed, has the air exhausted from its cavity, by the use of an air pump or exhausting syringe, machines of the same construction as the common pump, but far more delicate; the stop cock being then turned to prevent the ingress of the atmospheric air, the globe is detached and again weighed, the difference shows the weight of the common air extracted from its cavity. Then, having the gas to be examined ready in a graduated jar, with a stop cock cemented in the top, the two cocks are joined together, and carefully and slowly turned to prevent the rush of the gas from the jar into the globe, carrying along with it any of the fluid in the trough; and the jar sunk so as to bring the surface within and without the jar to the same level: the stop cocks are then shut, the globe separated from the jar, aed again weighed. As the weight of the common air extracted is to 1, or any other standard number, so is that of the gas which has supplied its place to the specific gravity of the latter. However carefully the experiment may be made, it should be repeated three or four times, and the mean of them taken as the true result. If the gases are weighed from a jar standing in a trough of water, a correction must be made for the moisture taken up by them, which at 60 deg. Fahr. is about one third of a gr. Troy for every 100 cubic inches. Although this seems trifling, yet it must be considered that this measure of some gas weighs, when quite dry, little more than 2 grains.

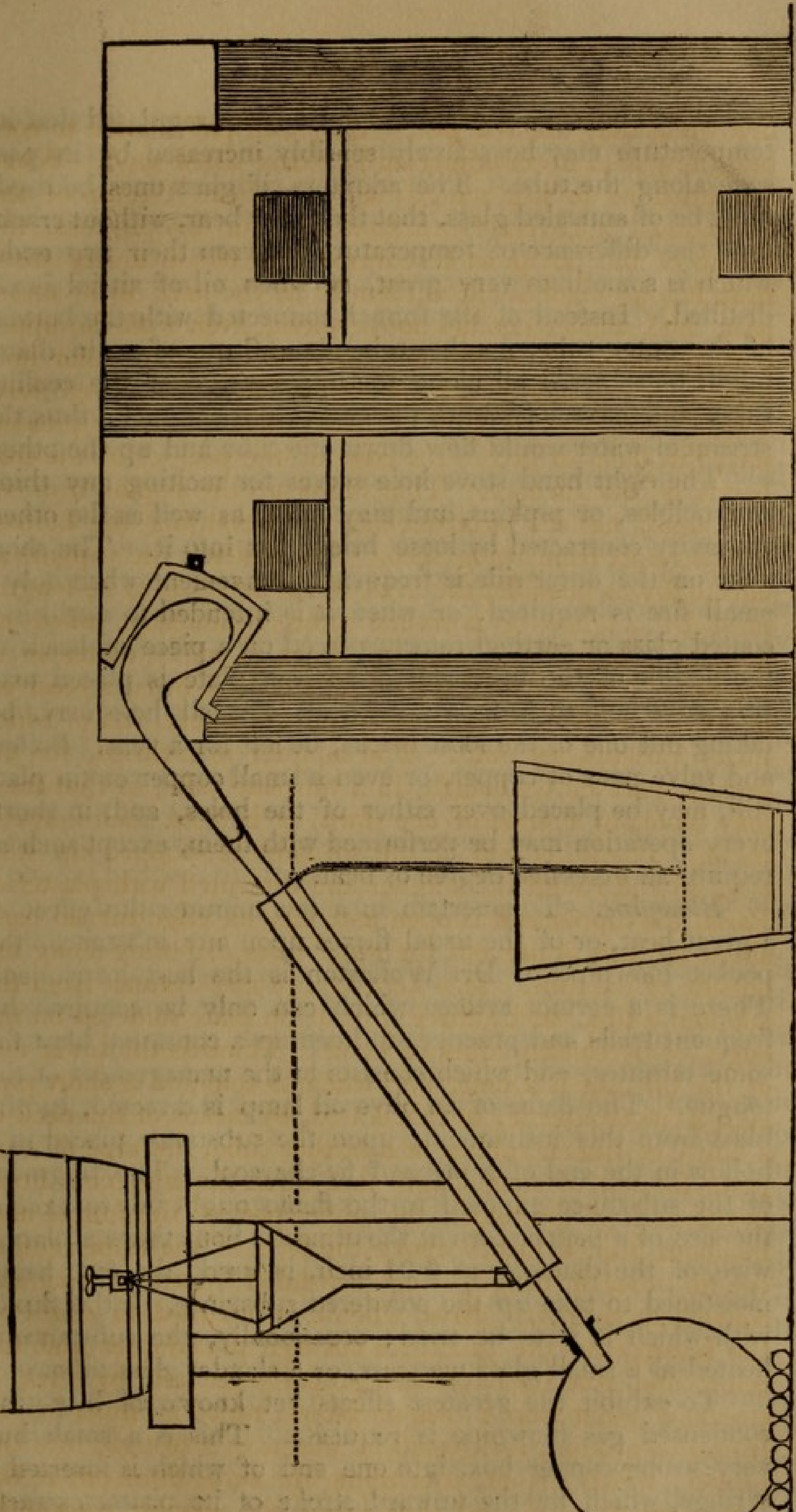
Statical Baroscope.—In consequence of the variable pressure of the atmosphere, as shown by the common barometer, the weight of any certain measure of the air is constantly varying, and of course its specific gravity. Now, bodies of the same weight, but of different bulks, when immersed in fluids of different specific gravities have their buoyancy altered, and of course their equilibrium destroyed. If, then, a large and very light glass bubble closed up, be counterpoised in a tender balance, with brass weights, the alterations in the pressure of the atmosphere will, from time to time, require the addition or subtraction of a certain weight to restore the equilibrium; from whence the pressure of the atmosphere may be computed. Or, this statical baroscope, as it is called, may be compared from time to time with a standard barometer, and the weight of the bubble corresponding to the different heights of the barometer, noted for future comparison.

Furnaces in general.—The application of heat is of continual use in chemistry, and many modes have been devised of applying it. The common Bath stove, with its hobs, is sufficient for many purposes. Jars, phials, and gallipots may be placed on the hobs; in these, solutions and other operations, that require only a moderate heat, may be performed, in winter without any expense. Copper or tin boilers may be placed on a trivet over the fire; and who of us, while a boy, has not practised the method of melting lead in a tobacco pipe between the bars? in this case, if the fire be urged by a small pair of double bellows, it will produce a still greater heat.

If two walls be built at a small distance from each other on a table, by laying a few bricks upon one another, and an iron grating, or even a gridiron with the handle cut partly off, placed so as to rest on these walls, a platform will be formed on which vessels may be placed, and heated by applying a lamp under them, or a small fire of lighted charcoal contained in a chafing dish, or still better in a cavity hollowed in a block of pumice stone, about 3 inches every way. This grating is much more useful than the pillar and rings, which is apt to be overturned unless great caution is used.

Vigani's Furnace.—If a stronger heat is required, so that the vessel containing the ingredients must be placed immediately over the lighted charcoal, or even immersed among the coals, then Vigani's invention is very convenient for a person who is confined for room, or for making experiments at an occasional residence. With an old fine-toothed saw, or only a bit of tin plate hacked on the edge, Windsor bricks, or pumice stone, are to be cut into small blocks all of the same size, generally three from each brick, by dividing it across in two places. A quantity of these blocks must be got ready, then placing a flat 12 in. tile on the table, or having a platform of bricks, about two feet high, under the chimney, the small blocks are to be laid in several rows about half an inch distance; upon these more blocks are laid, in similar rows, but crossing the first; a third or fourth stage of blocks may be laid in like manner; and thus a grate is formed on which the coals are to be placed, the necessary air passing up between the crossed rows. The fire place is then surrounded with a wall of similar blocks to a sufficient height, in which any opening that is necessary may be left, the blocks that are to close these openings being ground rather smaller that they may be easy to take out; and, if it be judged proper, the whole may be covered with a flat tile or stone, and an opening left in the side to allow the egress of the air from the fire. If it be required to prevent the access of air to any part, moistened ashes may be used to stop up the opening.

Stove Holes.—When a person devotes a room for a laboratory, then the stove holes, as they are usually called, are the most useful of all furnaces; and although this is so generally known, that they are not only to be found in all druggists' laboratories, but also even in all well furnished kitchens, where they are used for the nicer operations of household economy, yet they are not described in any of our elementary treatises of chemistry, which have, instead thereof, descriptions of French reverberatory furnaces, and other imperfect contrivances, not to be found in English laboratories. They are generally constructed in pairs, it being frequently necessary to mix together two substances at different temperatures; each of which, of course, requires a separate fire to prepare it. The most approved construction is to mark out a space on the floor, either under a chimney or hood that may carry off the vapours; this space is to be 37 in. and an half wide, and 21 inches from front to back. This space is to be surrounded with a wall of bricks laid on the flat sides, and with a similar wall in the middle of the open space; these walls are to be carried up to the height of 24 inches, by which means, two hollow prismatic ash pits, of 12 inches square, will be left, with a partition 4 in. and an half between them, and having the outward boundary walls of the same thickness. By the ash pits being thus tall, a good draught of air will be made, if at the bottom in the front of each ash pit a hole 5 in. by 4 be left to admit the air, whose ingress is to be regulated, either by a sliding door, or by a brick wedge, which being pulled out more or less, will allow more or less air to pass. On the top of each of these ash pits, is to be laid a grate, composed of iron bars 7-8ths of an inch square, set on their edges an inch apart, and connected by two end bars, which lie on two tiles, forming sufficient ledges in the walls of the ash pits. The walls are then to be raised 12 inches above the grate, leaving, in the front of each fire place a fire hole, 4 inches high and 5 wide, whose lower edge is about one inch above the grate, which is to be closed in the same manner as the ash hole, by a sliding door or brick wedge. The tops of the fire places are entirely open, and the walls are continued all round of an even height, except that there is set sloping in the outer side wall of the left hand fire place a cast iron pot, about 6 inches over and as many deep, so that the uppermost edge of the pot may be level with the top of the fire places; the pot being retained in the proper slope by an iron bar running across the fire place. The outer side wall of the right hand fire place is to be carried up only six inches from the grate, and the remainder left open; to which open place loose pieces of brick are to be fitted, to close it when it is not wanted to be open. It is most usual to have all the walls half a brick, or 4·5 in. thick as already described; but these thick walls occasion a waste of fewel and time in heating such a mass of brick work, and Weigel recommends the walls to be only 3 in. thick at the furthest. In this case, the walls are built of bricks set on edge, and they must be held together with iron braces fastened round the furnace with nuts and screws, and then plaistered over about half an inch thick of Windsor clay. Or, if an iron foundery is at hand, two hollow prisms, 15 in. square and 12 in. high, may be procured, with one side open to the depth of 6 inches, and having two openings 4 in. high and 5 wide, opposite to each other, in the lower edge of the front and back; these may then be set on the ash pit walls and lined with bricks. If the prisms have also a hole 7 inches wide and 8 high, in the middle of the side opposite to that which is left open to half its depth, an ingenious artist will find them very convenient in the construction of several kinds of furnaces for special uses. The common iron pots having three feet, two of them may be made to rest on the iron bar placed across the furnace; and if these be so long as to be in the way, they may be cut shorter with a common saw while they are red hot. This iron pot is used to contain the glass retorts immersed in coarse sifted sand. When it is intended to use a high degree of heat, the top of the retort must be covered with sand, and for this purpose, the mouth of the pot must be covered with two plates of sheet iron, having notches cut in them to let the neck of the retort pass, and smaller notches above these, even with the upper part of the mouth of the pot, to form a small circular hole through which sand may be poured to fill up the pot entirely. These iron plates are kept in their proper places by pins inserted in holes drilled in the edge of the pot, or of the iron bands of the furnace. This filling up the sloping iron pot with sand, has the inconvenience of preventing the bottom of the retort from being seen. To condense the vapours as effectually as possible, the neck of the retort is to be lengthened by a glass or porcelain tube, technically called an adopter, about 2 feet long and 3 qrs. of an in. diameter on the inside; at the further end of which is fitted a receiver, or sett of receiving vessels, with tubes of safety, &c. of which many varieties are sold. The adopter is inclosed, for the greater part of its length, in a tin plate tube, so that there may be about a space of one third or half an inch between them. The lower end of the tin tube is stopped up with tow, wound round the adopter and cemented with plaster of Paris, the upper end is open and has its edge turned back about an inch to prevent the water from dribbling along the outside of the tube. It is kept at a proper distance from the adopter at this end by three slips of tin plate soldered on the edge, or by small wedges of wood. Towards the lower end of the tin tube is a hole, into which is soldered a short pipe with a ring round it; to this is tied, by means of the neck of a bottle of Indian rubber or a leather tube, the pipe of a tin plate funnel, of such length that when the adopter is fitted to the neck of the retort, the upper part of the funnel may be about 3 or 4 inches above the level of the upper end of the tin tube, the funnel being suspended by strings from any convenient support. Now, when it is intended to distill by the retort, and the junctures between the adopter and the retort and receiver have been properly secured by lutes, a stream of water from a cask or cistern, raised a proper height from the ground, is directed by means of a trough, into the funnel; which stream, after filling the tube, flows out at the upper end thereof, and thus keeps the adopter constantly



cooled. The stream of water must be so regulated that its temperature may be scarcely sensibly increased by its passage along the tube. The adopters, if glass ones be used, must be of annealed glass, that they may bear, without cracking, the difference of temperature between their two ends, which is sometimes very great, as when oil of vitriol is redistilled. Instead of the funnel connected with the bottom of the outer tube, another tube about 3 qrs. of an in. diam. might be soldered all along the upper ridge of the cooling tube, and have its mouth expanded like a funnel; thus the stream of water would flow down one tube and up the other.

The right hand stove hole serves for melting any thing in crucibles, or pipkins, and may have, as well as the other, its cavity contracted by loose bricks put into it. The short wall on the outer side is frequently convenient when only a small fire is required, or when it is intended to distill in a coated glass or earthen retort, placed on a piece of brick in the middle of the fire; and if an iron plate is placed over this stove hole to form a sand heat, a small hole may, by taking out one of the loose bricks, be left for a vent. Boilers and salve pans of copper, or even a small copper or tin plate still, may be placed over either of the holes, and, in short, every operation may be performed with them, except such as require an excessive degree of heat.

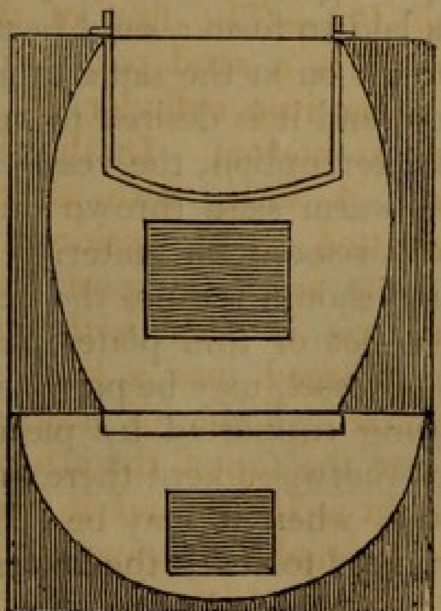
Blowpipe.—To ascertain in a few minutes the effect of a great heat, or of the usual fluxes upon any substance, the pocket blowpipe of Dr. Wollaston is the best instrument. There is a certain artifice which can only be acquired by frequent trials and practice, to keep up a continual blast for some minutes, and which consists in the management of the tongue. The flame of an olive oil lamp is directed, by the blast from this instrument, upon the substance placed in a hollow in the end of a piece of fir charcoal. The fragment of the substance exposed to the flame ought not to exceed the size of a pepper corn at the utmost. Sometimes a platina wire, of the diameter of 0·01 inch, is used, the end being moistened to take up the powdered substance, or the fluxes with which it is to be tried; occasionally, the substance is heated in a small glass mattrass, or a slender glass tube.

To exhibit the greatest effects yet known of heat, the condensed gas blowpipe is requisite. This is a small but very strong copper box, into one end of which is inserted a syringe, which by the upward stroke of its piston extracts either common air, hydrogen gas, oxygen gas, or a mixture of the two latter, from a bladder or jar annexed to it; and by its downward stroke forces them into the box. A stop cock inserted into the other end of the box gives, at pleasure, a passage to them through a pipe, by which the flame of a lamp is directed upon the substance exposed to it; and thus there is produced a far more powerful heat than by the common blowpipe or by any furnaces. As the mixture of hydrogen and oxygen gases gives the greatest heat, but is explosive, several modes have been put in practice to prevent the flame from being drawn into the box, and an explosion ensuing: such as having an intermediate vessel half filled with water or oil, through which the gases are forced; or a part of the tube made wider than the rest, and having two or three screens of wire gauze placed within it; or having this wide cavity filled with threads of glass or fine wire, so as to leave only capillary passages, through which ordinary flame would not pass. Even with all these precautions, such is the hazard of an explosion, that it is prudent, and indeed necessary, to fix the apparatus nigh a window opening into a private yard, and to place between it and the operator a strong screen of two inch plank, of sufficient height, and well secured by traverses, so that, should an explosion happen, the fragments of the apparatus may be driven through the window, without injuring the operator or any other person.

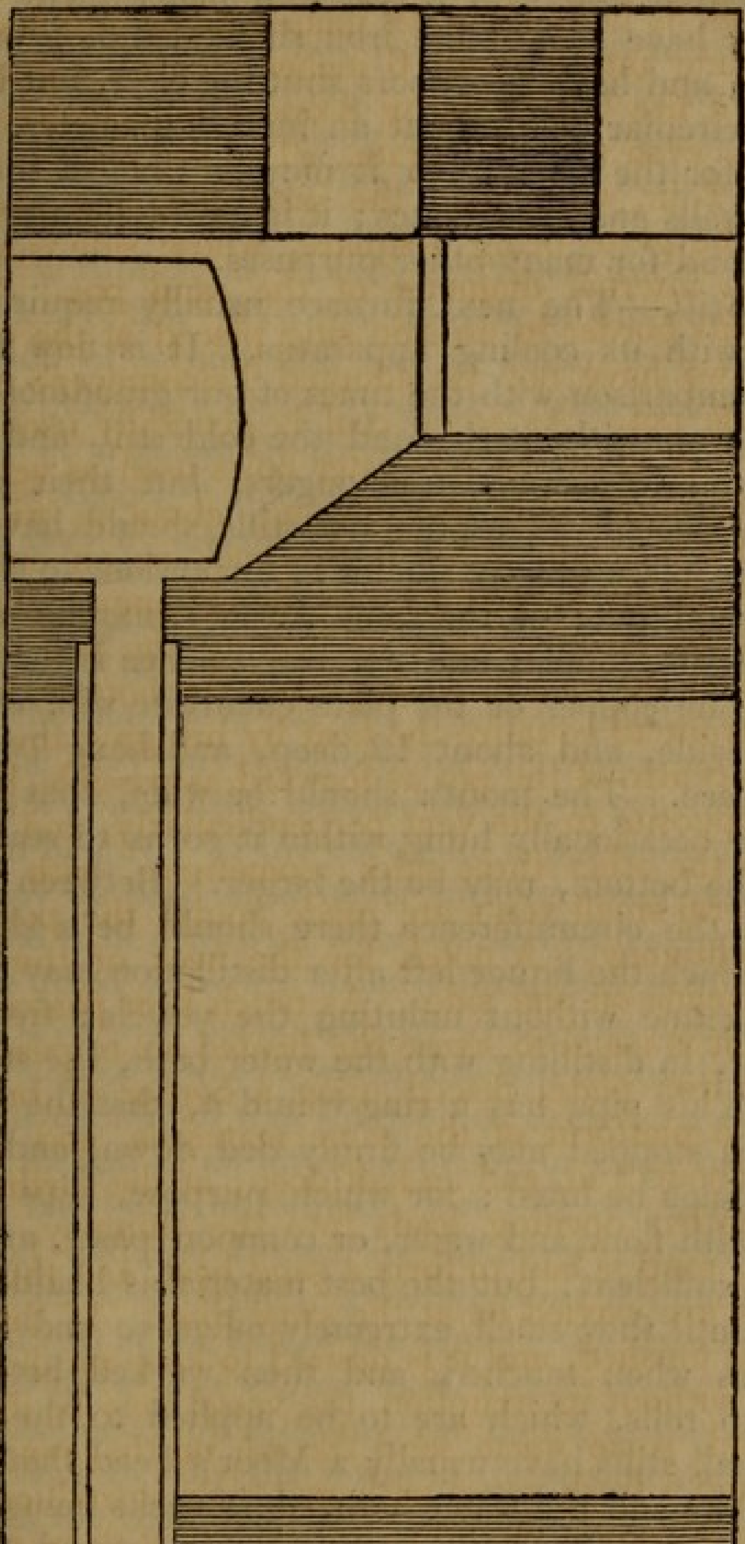
Special Furnaces.—Although the above apparatus is sufficient for exhibiting heat to answer almost every experimental purpose, and for the preparation of chemical agents and medicines on a middling scale, yet those chemists who engage in researches relative to chemical manufactures, or in preparing any article for sale, will find it convenient to adopt furnaces so adapted to their particular uses, that the saving of time and fewel will compensate for the additional expense of their construction. As the laboratories of experimental chemists are usually small, portable furnaces are frequently employed by them, especially by amateurs. Charcoal is, indeed, the only fewel that can be used in them, except the occasional use of the finer kind of stone coal that yield a bright flame, and burn to a white ash without forming clinkers. When the fire is regulated by the admission of only the necessary quantity of air through the charcoal, and the whole heat of the fewel is directed upon the subject exposed to it, the expense is not so great as might be supposed, for no other fewel gives out so much heat. One pound of charcoal will boil away 13 lb. of water, whereas the same weight of Newcastle coal will boil away only 8 or 9 lb. A lb. of coak will only boil away 4 lb. of water, and a lb. of peat seldom more than 5 lb. or by a skilful mode of using it at the utmost 10 lb.

For building fixed furnaces Windsor bricks are generally used, as they may be cut as easily as chalk, and yet bear a violent heat without alteration; they must be set in clay of the same field. The parts distant from the fire may be of common bricks set in mortar, but this mortar must be carefully removed before the other part is begun, as an accidental admixture of it with the clay would cause the latter to run into glass, and thus spoil the furnace. These furnaces are generally built as thin as possible, that they may take up the less room, and to save fewel in heating them as they have seldom fire constantly in them; in this case, they should be surrounded with iron braces, to prevent the alternate contraction and expansion destroying them as soon as they otherwise would. In building these close furnaces, the ash hole and vent are generally made too large, so that much unnecessary air passes through the fire and prevents its full effect, while a large portion of combustible matter is carried off unburned causing a disagreeable smoke, or is burned in the chimney itself and totally in waste. When the common stone coal is used, it requires, indeed, a large mass of fire to be kept up, and the action of the latter regulated by the admission of cold air above the fire; a wasteful, but with that fewel, a necessary mode of exhibiting heat.

Portable Sand Pot.—The first of these furnaces that is generally required is a sand pot. For a portable one, the ash pit may be an iron cylinder, 17 inches in diameter and 8 deep, closed at bottom. In the front is cut a hole 3 inches high and 4 wide, with sliders to shut close. Three pins are rivetted on the inside about an inch below the upper edge; these are to support the fire place. The bottom of this ash pit is lined with clay, beat up with charcoal dust and formed into a kind of saucer. The fire place is a similar cylinder of nearly the same width, so as to fit easily into the top of the ash pit, and rest on the three pins; its height is 15 in. and it has a flat border at each end, leaving a circular opening of 10 in. in diameter. Around the lower border are rivetted three screws, to which are fixed, by nuts, a grate. In the upper border, towards the circumference, and at equal distances from each other, are made four circular holes an inch over. The inside of this fire place is lined with clay and charcoal, whose surface is adjusted to a core, made by drawing on a board an ellipsis, having its foci 15 in. asunder, and its semiordinates at the foci 5 in. sawing off the board at each focus, and also down the greatest diameter, so that the internal cavity may represent an ellipsoid of those dimensions, cut off at the foci. A fire hole about 6 in. wide and 4 in. and an half high, with the lower limit about 3 in. above the grate, is left in the front, to be closed with a lined stopper; both the fire hole and stopper having a border to retain the lining. When the lining is dry, four openings are cut sloping through it, corresponding to the openings in the upper border, to serve as vents for the burnt air, and to regulate the fire by sliding pieces of tile more or less over them. In the central opening at the top of the fire place is hung a cast iron pot, either hemispherical, or, which is most usual, cylindrical, about 6 in. deep at the edge, with a rounded bottom, so that the axis is about an inch deeper. The common pots have only a reflected border by which they hang; but the best kind have also an upright edge that rises an inch higher, to which a stone ware head is fitted; and thus the pot serves for many distillations that require a strong fire. It is usual to cut a notch on one side of the top of the fire place, sloping upwards to the edge of the pot, about 3 inches wide and 2 deep, to admit a low retort to be sunk deeper into the pot by allowing a passage to its neck.



Sand Heat.—A furnace of this kind may be stationary, and built of bricks that will stand the fire; and in this case, the ash pit is built about 12 inches high, and has an ash door opening into it about 6 inches square; a grate is then laid, and a fire door 6 in. by 8 opens immediately into the fire place, even with the grate. The fire place is made cylindrical, 2 in. wider than the sand pot, and about 8 in. deeper; the grate being a square, whose side is about two thirds the internal diameter of the sand pot. This pot hangs by its border in an iron ring placed at the top of the furnace; we have not yet adopted Teichmeyer's method of sloping the pot. As stone coal is generally used in fixed furnaces, instead of the 4 register holes used as vents in the portable furnaces, only one opening, about as wide as the grate and 3 in. high, either in the back or on one side, is made to vent the burned air into the chimney. This, however, has the inconveniency of heating the pot unequally, the side next the vent becoming much the hottest, in spite of the endeavour to equalize the heat by bringing the fire from under the centre of the pot as forward as possible, by raising the wall opposite to the vent perpendicularly, and enlarging it only on the other three sides: sometimes, with the same view, several small vents are made round the pot, leading into the chimney. A notch for the neck of the retort is generally made on one side. As much heat passes through the vent, it is usual to cause the heated air to pass under a large cast iron plate, placed upon a border of bricks surrounding a platform of the same materials, and leaving a cavity of about 2 in. and an half deep; at the further end of which, another opening leads into the chimney. On this iron plate, sand is laid to form a sand heat, and thus several operations are carried on at the same time. If that in the sand pot is finished, and it is desired to keep on those in the sand heat without interruption, the vessel may be drawn out of the sand, some warm sand thrown on that remaining in the pot, and a fresh vessel with materials introduced. But if this new operation should require the heat to be more gradually exhibited, a pot of thin plate iron, filled with cold sand, containing the vessel, may be partly slid into the heated sand pot, and, being supported by pieces of brick placed under the edge or otherwise, kept there until it be necessary to increase the heat, when it may be slid down lower until at length it is permitted to reach the bottom of the sand pot.

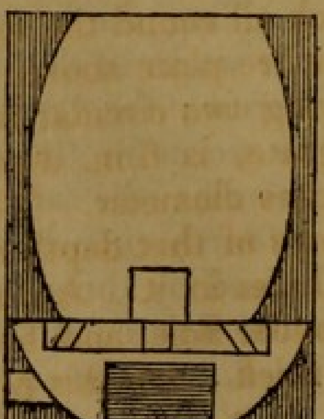


The platform under the sand heat, may be made hollow, and covered at top with a cast iron plate. The oven this forms may have some plate iron shelves, sliding on pins in the walls; and have iron doors shutting close, but having at the top a circular hole, about an inch in diameter, to allow a passage for the vapour: or it may be divided into chambers, by walls and iron plates; it is useful for drying salts or herbs, and for many other purposes.

Hot Still.—The next furnace usually required is the hot still, with its cooling apparatus. It is now but little used in comparison with the times of our grandmothers, few of whom were without this and the cold still, and it is yet sold by the furnishing ironmongers, but their stills are badly constructed. Portable hot stills should have an ash pit and fire place exactly similar in dimensions to those used with the sand pot; or the same furnace may be used with a hot still, if economy and not convenience is the principal object. The copper or tin plate cucurbite will, of course, be 10 in. wide, and about 12 deep, and hang 7 in. within the fire place. The mouth should be wide, that the water bath to be occasionally hung within it so as to reach within 3 in. of the bottom, may be the larger. Between this wide neck and the circumference there should be a short pipe, through which the liquor left after distillation may be drawn off by a crane without unluting the vessels; fresh liquor added; or, in distilling with the water bath, the steam may escape. This pipe has a ring round it, that the cork with which it is stopped may be firmly tied down, and like the other joinings be luted; for which purpose, slips of paper smeared with flour and water, or common paste, are usually esteemed sufficient; but the best material is bladders rotted in water until they smell extremely offensive and adhere to the fingers when touched, and then worked between the hands into rolls, which are to be applied to the joinings. These small stills have usually a Moor's head that fits both the cucurbite and the water bath, their necks being of equal diameter, and is furnished with a groove round the lower part on the inside, to direct the condensed vapour to the nose of the alembick; and this head is surrounded by a refrigeratory containing cold water, which is not so cumbersome and less expensive than a worm and tub. But the most advantageous way of cooling the vapours, is to use a Moor's head without a surrounding refrigeratory, or only a plain bent tube, which should be at least 18 in. long, that the small globules of the boiling liquor which are thrown up near a foot high, should not pass over, and render the distilled liquor unfit for keeping. To this is to be adapted a pewter pipe, about 8 feet long if spirit of wine is to be distilled, or shorter for watery liquors, and in both cases 3 qrs. of an in. in diameter on the inside, inclosed in a tinned plate tube with a funnel, as already described under the article Stove Holes, p. 38. With an adopter of this kind, and the consumption of a pint and half of water in a minute, or about nine gallons in an hour, spirit of wine may be distilled at the rate of a gallon by the hour, from one of these portable stills. Another convenience of these straight pipes is, that they may be cleansed in the same manner as a fowling piece.

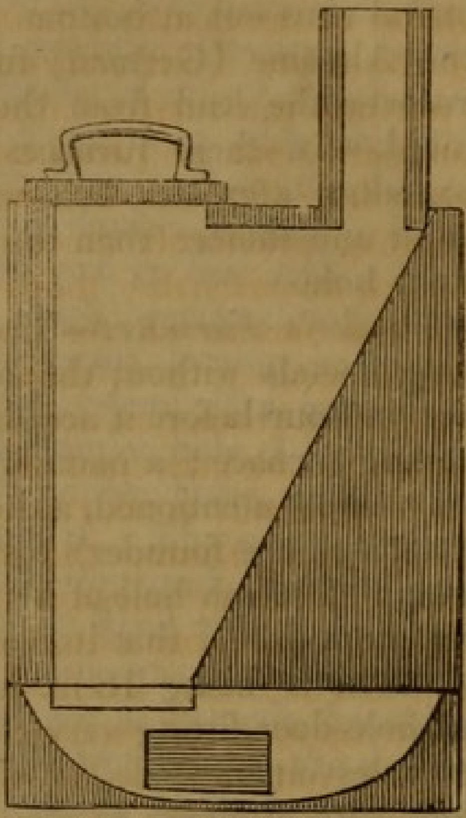
Large Still.—If this furnace is fixed, and made of bricks, it may be constructed with a sand heat like that annexed to the sand pot; but this is seldom practised, although it would be very advantageous for digestions and evaporations with a gentle heat, because the fire is generally kept up at an even height. If the cucurbite is not wanted for distilling, it may be used as a boiler to keep water ready heated for use, and to be drawn off when wanted by a siphon or crane. But these fixed stills are usually furnished with a pipe and cock on a level with the bottom, by which they can be emptied, and have almost always a worm and tub to cool the vapours; the head is usually of that kind which is called a swan's neck. Latterly, instead of an inner cucurbite, or water bath, the use of steam has been introduced, but this requires a complex apparatus; and the French for distilling their brandy have used a series of cucurbites, generally four in number, with a worm and tub at the end of the series; the 2d, 3rd, and 4th cucurbites have also worms fixed within them, so that the vapour produced by distilling the liquor in the first cucurbite, is condensed by the worm in the second cucurbite, and thus heats the liquor therein; the vapour of which is, in its turn, condensed by the worm in the third cucurbite, and thus heats the liquor therein; the same process takes place between the third and fourth cucurbite; the vapour raised from the latter is condensed by the common worm and tub. When the material in the first cucurbite is exhausted, it is drawn off, and replenished from the second; as this is from the third, and that from the fourth. But these complex machines are only fit for great capitalists.

Blast Furnace.—The third extra furnace is a blast furnace for smelting metals; it is formed on the same model as the two preceding portable furnaces, but rather smaller. The ash pit is a cylinder of only 12 in. diameter and 5 deep, with an opening in front, 4 in. wide and 3 deep, having a door that shuts very close, and on the side, a hole to admit the nozzle of a pair of double bellows. It is lined, like the furnace for the sand pot or hot still. The fire place is a cylinder only 12 in. high, partly closed at each end with a ring an inch and half broad, leaving an opening of 9 inches. To the lower opening instead of a grate is affixed an iron plate, pierced with a circular hole, 1 inch in diameter, in the centre, and having 6 similar holes, only half that width, at equal distances around it. The upper surface of this plate is to be covered with clay and charcoal powder, an inch thick, and it is to be so fixed that the upper surface of the lining may close the lower opening of the fire place. When the lining is dry, holes are to be made through it corresponding to those in the plate, the holes in the circumference being made to slope, so that the blast through them may all be directed to a point about 6 in. above the centre. The cylinder is likewise to be lined, and the cavity formed into an ellipsoid cut off at the foci, which are 12 in. asunder, and the semiordinates at the foci 4 in. and an half. When this furnace is used, a block, made of Windsor brick, is stuck in the central hole of the fire plate, by which means it is kept steady. Upon this the crucible or long pot is placed, and the furnace being filled with charcoal, it is lighted at top, and if the ash hole door be closed, and the bellows worked, a very violent heat will be speedily excited, at little expense of fewel.



Fixed furnaces of this kind are seldom used in laboratories, but metallurgists employ them, although without a grate, for smelting ores, which are put in at top on the coals, and the revived metal runs out at bottom. This is also the construction of the Almaine (German) furnace of the refiners; used to recover the lead from the tests and cupels that have been used. In these furnaces it has been observed, that they produce a greater heat when the nozzle of the bellows is smaller and shorter than the blast hole, than if it accurately fit the hole.

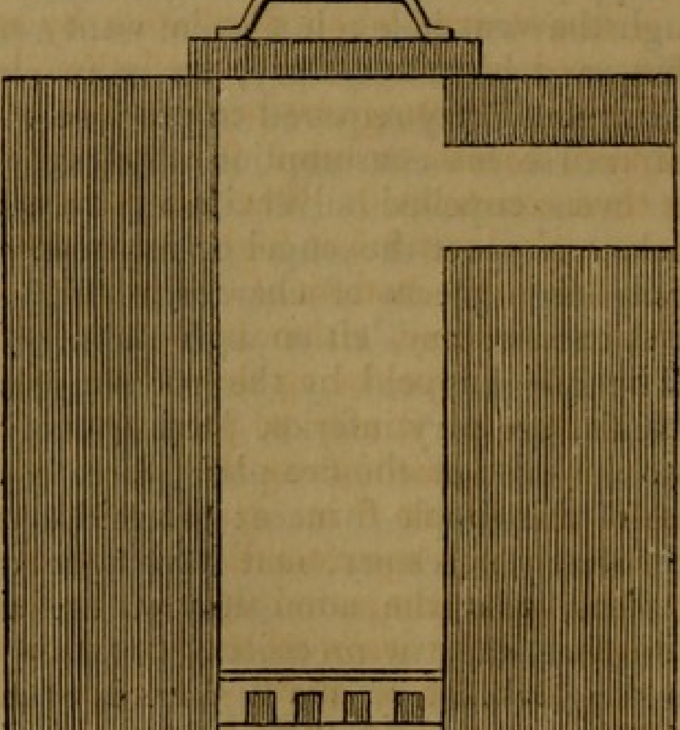
Melting, or Founder's Furnace.—The next furnace is intended for melting metals without the labour of blowing, but it requires near an hour before it acquires its full power. It is called the melting furnace; a name which, however, is also bestowed upon the last mentioned, although improperly; and it is also denominated the founder's furnace. Dr. Black first made it portable. The ash hole of his furnace is similar to those of the preceding, except that its horizontal section is oval; the longest diameter being 18 in. and the transverse 14. It has an ash-hole door fitting very close, and a series of 6 or 8 circular holes on one side, of different sizes in a regular progression, with stoppers to regulate the draught. The fire place is also oval, and 15 in. high, without any opening in its sides, and is closed at the bottom by a plate, pierced by a circular hole about 6 in. in diameter; which hole is not in the centre of the oval, but within an inch and half of one of the ends, or vertexes, of the ellipsis. Under this hole is affixed a grate. The fire place is entirely open above, but within an inch of the top three or four pins project inwards, about an inch long, to support the cover. The inside is lined, so as to form a reverse oblique cone, the cavity of which is brought up straight in front from the hole at bottom, but spreads out gradually behind so as to become only an inch and half thick all round the top. The cover is a flat plate fitting into the fire place above, and resting upon the projecting pins; having two circular holes; the one in front, directly over the grate, is 6 in. diameter, the other towards the back, is 4 inches diameter. This cover is lined an inch thick, having hoops of that depth round its circumference, and that of the holes in it. An iron pipe about 8 in. long is fitted to the smaller hole, and lined within, about three quarters of an inch thick. On this pipe, others of unlined plate iron are placed to the greatest height that convenience will allow.



An iron plate may be placed across the chimney of the laboratory, nearly as high as a person can reach. The plate to have two holes, one square and large, with a falling flap, which when down shuts it close, and when up rests against the back of the chimney; the other circular, 9 in. in diameter, to receive, on occasion, the iron pipe of the portable furnaces; the intervening space being closed by two pieces of iron, cut so as to embrace the pipe and close the opening. Then the square flap being let down, and the current of air up the chimney thus stopped, except through the furnace, the fire receives the whole benefit of the height of the chimney, and the iron pipes need not be higher than just to pass through the opening in this register plate.

When this furnace is used for fusions, a block of Windsor brick about two inches thick, rather wider than the bottom of the crucible, is usually put on the grate; upon this block the crucible is placed; the furnace filled with charcoal, lighted at top; the hole over the fire closed by a cover, having a rim, and lined like the rest of the furnace; then, by opening the registers at bottom, and sliding a small tile over the chimney, which ought not to be higher than is judged necessary to produce the intended heat, the fire is brought on gradually to prevent the crucible from cracking. Fresh fewel is added from time to time by the hole over the fire, and the condition of the matter exposed to the heat inspected by sliding the cover a little forwards. If a fresh crucible is to be put into the furnace already at work, the fire is either taken partly out or permitted to burn down rather low, a shovel full of fresh charcoal is then to be added, and the crucible, previously dipped in water, is put on them with its mouth downwards; the registers below are nearly closed, and the mouth of the furnace left open. When the crucible is ignited, it is then turned upright, bedded in the coals, and its bottom examined; should a dark streak show its bottom is slightly cracked, a pinch or two of powdered glass will generally render it serviceable. The simple form of this furnace pleasing the chaste eye of Dr. Black, he employed it for every purpose that it could possibly be used. Sometimes he hung a sand pot in the mouth, or a portion of a copper cucurbite, made narrower than the rest; or a crow foot to support an earthen retort, which he covered with small tiles, and these again with wood ashes to keep all close. In these cases the chimney was not used, and if any supply of fresh fewel was wanted, it was introduced through the vent hole; but as he went very patiently to work, this was seldom necessary, no more air being admitted than was absolutely required to produce the necessary heat, and of course his consumption of charcoal was very small. He even cupelled silver in it, by using a tall block of brick to support the cupel or ash test, and making his fire of only large pieces of charcoal, which afforded a free current to the air, and left enough unburned to scorify the lead. The furnaces sold by the ironmongers under the name of Black's, are very inferior, having many doors and openings into the sides of the fire place, directly contrary to the main idea of this simple furnace: to avoid every opening that is not absolutely necessary, and have none on the side of the fire place, that the admission of the air may be regulated with thermometric precision.

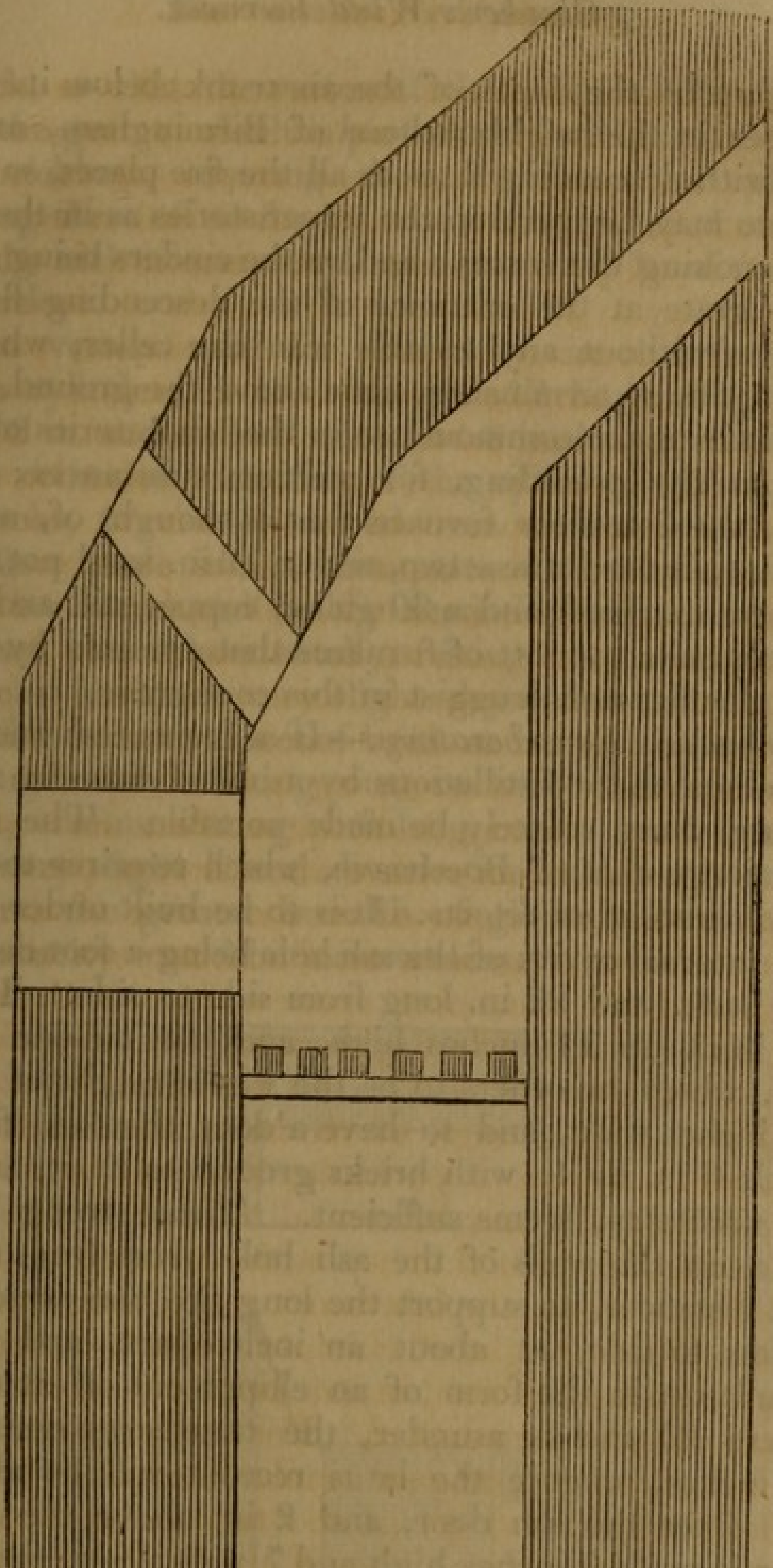
In a standing laboratory this furnace is equally simple. That the operator may be complete master over his crucibles the grate is placed nearly on a level with the ground, the ash pit being only about 6 or at most 9 in. high, open on both sides, but close in front. The fire place is generally a rectangular prism; the internal cavity having its sides of 9 inches, and its depth 24. Two rows of bricks are laid parallel to each other, at 9 in. distance, to form the front and back of the ash pit. Upon these are placed two strong iron bars to support the fire bars, and another course of bricks laid, leaving spaces for the reception and expansion of the bars. Two broad iron bars are then laid a little above the fire bars to support the sides of the fire place, which is continued up of bricks capable of bearing the fire. In the back of the furnace is left a vent, usually 4 in. high, and 7 wide, which being covered over communicates with a chimney into which no other furnace opens. The cover of these furnaces is usually made of an iron case lined next the fire with clay and charcoal and having a handle. The grate is composed of 4 or 5 loose iron bars an inch square, which are laid sometimes closer, sometimes more open, by taking one out or putting one in, as is judged proper, to regulate the draught. By this construction, the radiant heat from the bottom of the fire is prevented from incommoding the operator as he stands before it; and when the fire bars are burned the furnace is not required to be pulled down to replace them.



Charcoal is the best fewel for this furnace; if coak be used, it forms clinkers in a violent heat, which clogs up the fire bars and requires them to be continually cleared by a fire hook, and those adhering to the sides, occasionally removed by a 4 feet poker, terminating in a 3 in. chisel edge. Chenevix has proposed to make this furnace 3 in. wider at bottom than at top; but this is unnecessary, for the crucibles themselves, being narrower at bottom, allow the fewel to descend with ease. The founders usually make these furnaces of a cast iron cylinder of 14 in. diameter internally, and 18 high; having a notch, of sufficient size for the vent into the chimney, cut in the upper edge. When set up, they line it 2 in. thick with the black sludge obtained from the grinders of looking glasses, consisting of grinding sand intermixed with particles of glass, and which conglutinates by heat into a solid mass. As they use only charcoal, and have no occasion to clear their grate, the ash pit is sunk into the ground, made very large, and the air admitted into it through a grate on which the operator stands. Sometimes, to have still greater command over heavy crucibles, the fire place itself is sunk so that the mouth is level with the floor.

Glauber's Wind Furnace.—The lowness of the last furnace, although very advantageous in the management of crucibles, is as awkward when distillation by strong heat in a wheel fire, and calcination or cupellation, is to be performed. For the advantageous performance of these operations, Glauber's fourth or wind furnace, called also an air furnace, is thus constructed. The ash pit is a hollow prism, 12 in. square and about 3 feet high: an opening of about 6 in. square, is left at the bottom of one or both of its sides, to be closed when necessary, either by a slider or with a brick wedge, so that the stopper being drawn out more or less, the draught of air through it may be properly regulated. Two strong iron bars are placed across the top of this ash pit from front to back, and about 6 in. apart; on these are laid six iron bars, near an inch square and scarcely more that 11 in. long, with their ends hammered up so as to keep them near an inch asunder. The walls of the fire place are continued up to the height of 12 in. above the upper surface of the grate, of Windsor or other fire bricks, set in the loam of which they are made. An opening is to be left in the front, 8 in. high and 6 wide towards the internal part, but widening externally on the sides to the width of 10 inches, the lower limit being level and between 2 and 3 in. above the grate, so that if a brick be placed thereon the whole may form an even surface. The furnace then contracts gradually for another foot in height towards the vent, which is generally 4 in. by 9, or 6 in. square, opening into the chimney; but, according to Boerhaave, this vent should be only 3 in. square. An opening is made in this sloping part, 4 in. high and 6 wide, sloping downwards itself, being partly used to feed the fire, and partly to inspect the condition of the matter in the crucible; the lower limit being about 3 in. above the internal upper limit of the crucible door. Both these openings are to have stoppers fitted to them.

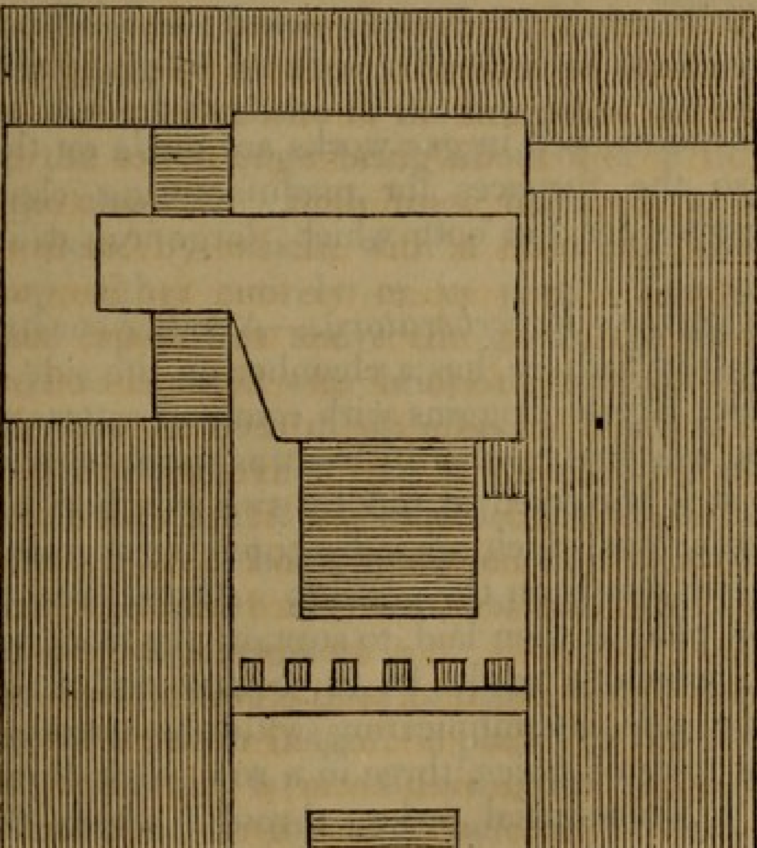
When this furnace is used for calcinations, or other operations under a muffle, a brick cut sloping on the farther end and sides, that it may intercept less of the air, is placed on the grate; on this the muffle or arched earthen oven is put, and the remainder of the opening is closed up with pieces of bricks and clay; the mouth of the muffle is also closed with a brick. In distillation with a wheel fire, a piece of brick hollowed at the top is placed on the centre of the grate to support the retort, the neck of which projects through the opening, and the remaining space is closed with bricks and clay. This furnace, like the preceding, requires for its full effect a strong draught of air, and consequently, a chimney of sufficient height, into which no other furnace enters. Hence, when neither a particular flue can be allowed for them, nor their chimney be carried through a register plate, placed across the main chimney of the laboratory, as already described; or when, the laboratory itself being on an upper floor, a sufficient height of chimney, which, it is supposed, ought to be at least 30 feet, cannot be obtained, some peculiar contrivances must be adopted. For this purpose, a pipe of about 6 in. diameter, or some similar channel of brick work, is carried from the ash pit of the furnace to the outside of the house or laboratory. Then if the laboratory chimney is of sufficient height, the ash hole is carefully closed, and the doors and windows being also kept shut, the whole of the air that is forced by the heat up the chimney, is drawn through the fire, being supplied by the air trunk from the outside of the laboratory. If the chimney is too short to produce the necessary effect, the air trunk is, if possible, to be continued down to the ground floor, or even the cellar, to the end that what is wanting in the height of the flue above the fire, may

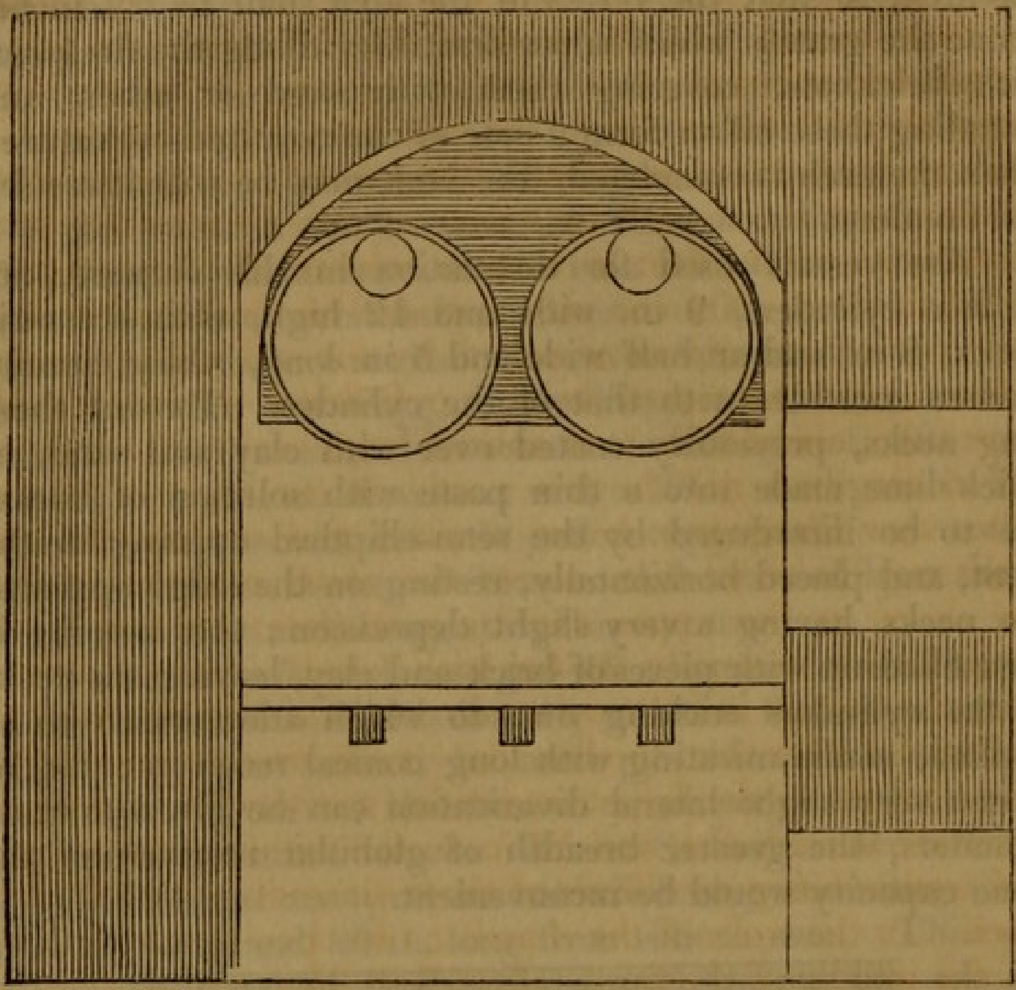


be made up by the depth of the air trunk below it. Some warehouses in the neighbourhood of Birmingham, are constructed with descending flues to all the fire places, so that as good a fire may be made in the upper stories as in the lower, without smoking the rooms; and on the cinders being pushed over the grate at the entrance of the descending flue, the ashes drop without any trouble into the cellar, where the descending flues terminate a little above the ground. This furnace is in more common use in the laboratories of druggists, than the preceding, for melting substances; and is generally the first close furnace that is thought of, after the stove holes; indeed, these two, with a 12 in. sand pot, having a sand heat annexed, and a 30 gallon copper still and worm, usually compose the sett of furnaces that are used by a shop-keeping chemist and druggist in this country.

Boerhaave's Reverberatory.—If a furnace should be required adapted to distillations by a naked fire, on a rather large scale, it can scarcely be made portable. The smallest construction is that of Boerhaave, which requires the use of long necks instead of retorts. It is to be built under a chimney, the internal cavity of the ash hole being a foot deep from front to back, and 22 in. long from side to side. This ash hole is built up 11 inches high, and has on one side an opening, which he orders to be the whole height of the ash hole, 4 inches wide, and to have a door that will fit close; but a hole 6 in. by 4, with bricks ground to fit it, and close it when necessary, seems sufficient. Three strong bars are then laid on the walls of the ash hole, from front to back, at equal distances, to support the long fire bars which reach from side to side, at about an inch apart, and the fire place built up in the form of an ellipsis cut off at the foci, which are 20 inches asunder, the transverse diameter to be 15 inches, whence the latus rectum will be about 12 inches. Over the ash door, and 2 in. above the grate, a fire door is made 9 inches high and 7 wide, to be closed with a stopper. The walls are continued up to the height of 16 inches above the grate, but an opening is left in the front 10 in. above the grate, of a semi-elliptical form, 20 in. long and 12 in. high in the middle. On the back wall opposite to this opening, but an inch lower, a ledge of an inch and an half is left to support the long necks. A vent hole 3 in. wide and 2 high, is left in the upper part of the middle of the back wall. The furnace is then covered in by an elliptical arch, so that the vertex of the arch shall be 22 inches above the grate; which is performed by filling the fire place with brickbats, covering them with sand or ashes, and rounding these off to form a core of the required curvature; when the arch is completed, the core may be withdrawn by the fire door.

The vessels used for distillation in this furnace, are earthen cylinders, 9 in. wide and 12 high, with eccentric necks, 3 in. and an half wide and 5 in. long, whose circumference coincides with that of the cylinder. Two of these long necks, previously coated over with clay and sand, or quick lime made into a thin paste with solution of borax, are to be introduced by the semi-elliptical opening in the front, and placed horizontally, resting on the ledge opposite, the necks having a very slight depression; the opening is then filled up with pieces of brick and clay, leaving the necks of the cylinders sticking out, to which adopters are to be applied, communicating with long conical receivers; for, as only a very slight lateral divarication can be given to these cylinders, the greater breadth of globular receivers of the same capacity would be inconvenient.

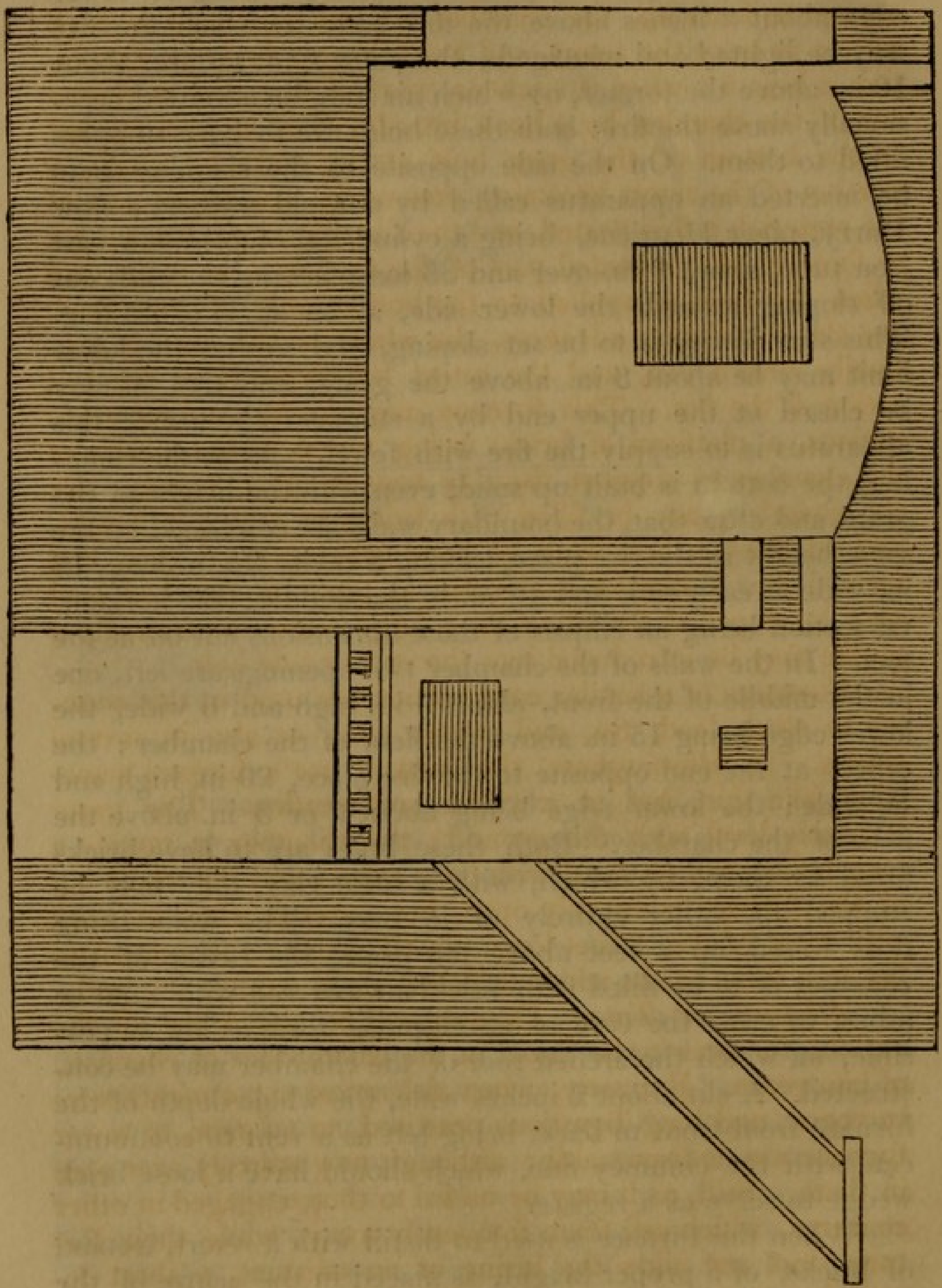




The furnaces used in gas works are made on this model, as are also the furnaces for manufacturing charcoal for making gunpowder; in both which, large iron cylinders are used.

Dr. Higgins's Reverberatory.—Another construction of a reverberatory furnace has a chamber on the side, and was used by Dr. Bryan Higgins with common retorts and stone coal. The ash hole is open in front as usual with stone coal furnaces; it is traversed at top by two iron bars to support the loose iron bars which are substituted for a grate, and are laid about two feet from the ground. Above this loose grate a thick iron plate is then laid, to support the front wall of the fire place; which is made 12 in. square and 24 in. high, but on the side communicating with the chamber are to be left four rows of holes, three in a row, each 2 in. square, placed in a quincuncial order, through which the flame and heated air may pass into the chamber, and any cinders that may be carried over by the draught of air, be stopped in their ascent. In the front of the fire place are also to be left two openings, the one 6 in. square, having its lower edge about 2 inches above the fire bars, by which the fire may be lighted and managed; the other 2 in. square, about 10 in. above the former, by which air may be admitted occasionally above the fire: both these holes are to have stoppers fitted to them. On the side opposite to the chamber is to be inserted an apparatus called by our old authors a slow Harry, piger Henricus, being a cylindrical or prismatic cast iron tube, about 9 in. over and 36 long, having the ends cut off sloping towards the lower side, at an angle of 45 deg. This slow Harry is to be set sloping, and so that the lower limit may be about 3 in. above the grate, and that it may be closed at the upper end by a stopper: the use of this apparatus is to supply the fire with fewel. As to the chamber, the bottom is built up solid, even with the height of the grate, and after that, the boundary walls are continued up the same height as the fire place, leaving a cavity 24 in. long, 12 in. wide at each end, and 18 in. in the middle: the horizontal section being an ellipsis of those dimensions cut off at the foci. In the walls of the chamber two openings are left, one in the middle of the front, about 9 in. high and 6 wide, the lower edge being 15 in. above the floor of the chamber; the other, at the end opposite to the fire place, 20 in. high and 12 wide; the lower edge being about 2 or 3 in. above the floor of the chamber. Both these holes are to have bricks fitted to them, by which, with a little clay, they may be stopped up, either entirely or in part. The walls being thus raised up 2 feet above the grate, the cavity of the chamber is to be filled with brickbats covered with sand or ashes, to make the core of an elliptical form as low as possible, on which the arched roof of the chamber may be constructed. A slit about 2 inches wide, the whole depth of the furnace from front to back, being left as a vent to communicate with the chimney flue, which should have a loose brick wedge to serve as a register.

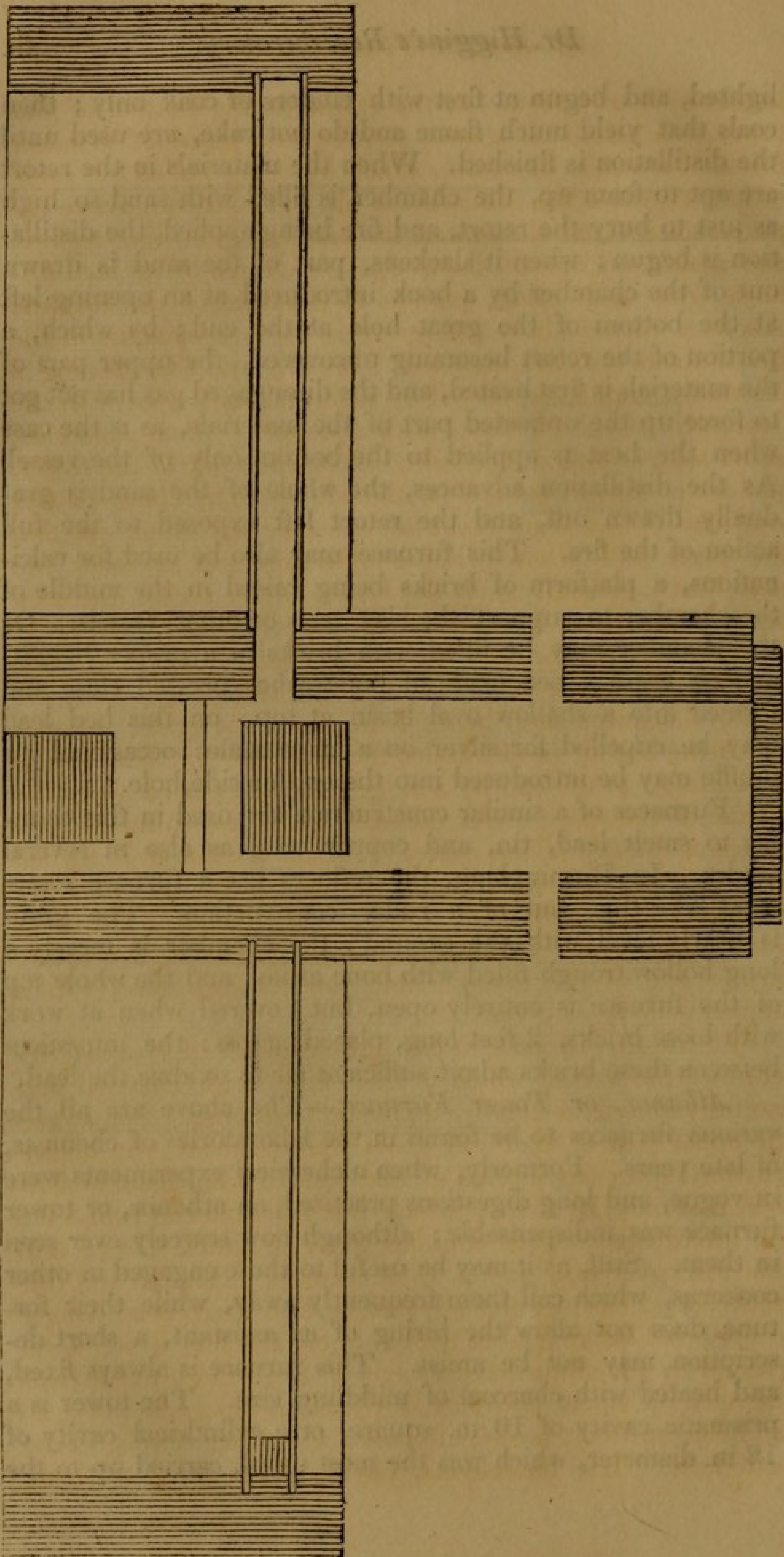
When this furnace is used to distill with a retort, a stand of bricks, of a proper height, is placed in the centre of the chamber; the retort is introduced either through the small hole in the front, or the large hole at the end, which are then bricked up, and a receiver being applied, the fire is



lighted, and begun at first with cinders or coak only; then coals that yield much flame and do not cake, are used until the distillation is finished. When the materials in the retort are apt to foam up, the chamber is filled with sand so high as just to bury the retort, and fire being applied, the distillation is begun; when it slackens, part of the sand is drawn out of the chamber by a hook introduced at an opening left at the bottom of the great hole at the end; by which, a portion of the retort becoming uncovered, the upper part of the materials is first heated, and the disengaged gas has not got to force up the unheated part of the materials, as is the case when the heat is applied to the bottom only of the vessel. As the distillation advances, the whole of the sand is gradually drawn out, and the retort left exposed to the full action of the fire. This furnace may also be used for calcinations, a platform of bricks being raised in the middle of the chamber to support the clay tests or other vessels. Or the chamber may be filled with bricks to a proper height, and on these a bed made of bone ashes pressed close and formed into a shallow oval basin at top: on this bed lead may be cupelled for silver on a large scale: occasionally a muffle may be introduced into the end or side hole.

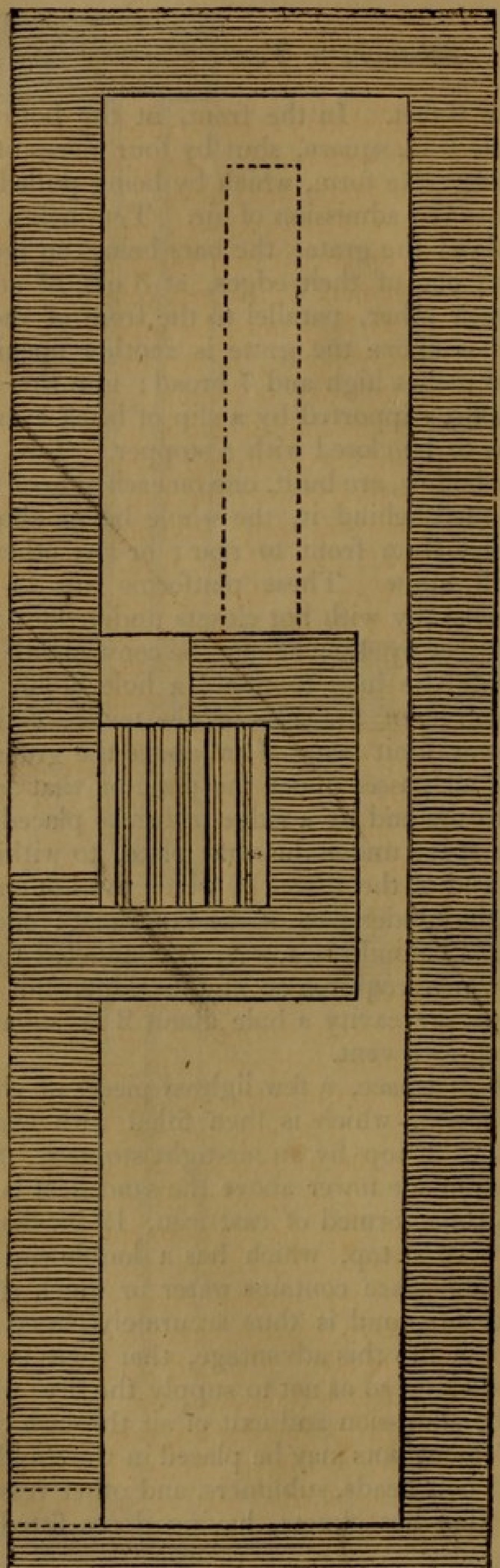
Furnaces of a similar construction are used in this country to smelt lead, tin, and copper ores, as also in several trades. In Birmingham, the refiners use a furnace somewhat like this, but of a ruder construction. The grate is nearly level with the ground; the chamber is merely a long hollow trough filled with bone ashes; and the whole top of the furnace is entirely open, but covered when at work with loose bricks, 2 feet long, placed across: the interstices between these bricks admit sufficient air to oxidize the lead.

Athanor, or Tower Furnace.—The above are all the various furnaces to be found in the laboratories of chemists, of late years. Formerly, when alchemical experiments were in vogue, and long digestions practised, an athanor, or tower furnace was indispensable; although now scarcely ever seen in them. Still, as it may be useful to those engaged in other concerns, which call them frequently away, while their fortune does not allow the hiring of an assistant, a short description may not be amiss. This furnace is always fixed, and heated with charcoal of middling size. The tower is a prismatic cavity of 10 in. square, or a cylindrical cavity of 12 in. diameter, which was the most usual, carried up to the



height of 4 or 6 feet. In the front, at the bottom of this tower, is a hole 6 in. square, shut by four pieces of Windsor brick, of a wedge like form, which by being pulled out more or less, regulate the admission of air. Ten inches above the pavement is fixed the grate, the bars being an inch square, and placed on one of their edges, at 3 qrs. of an inch distance from each other, parallel to the front of the furnace. About 2 inches above the grate is another opening in the front, about 6 inches high and 7 broad; into this opening is inserted a muffle, supported by a slip of brick even with the door, which is to be closed with a stopper. Two platforms, either solid or hollow, are built, one on each side of the tower, and are continued behind it, the whole being about 12 feet long and 3 feet from front to rear; or any other size that the place will allow. These platforms are to form two sand heats, generally with hot closets under them; the sand plates being 2 feet by 4, or as may be convenient. In order to communicate the heat to them, a hole is cut 5 in. wide and 2 high on one of the sides of the tower, and next the front, the lower limit being 3 in. above the grate, through which the hot air passes under the plate on that side, and is forced to go to the end by a ridge of bricks placed along the middle of the space under the sand plate, to within about 4 inches of the end of the space, by which the hot air is turned back to heat the hinder part of the sand heat; and then, by a channel made behind the tower, is conducted to the other sand plate, which requires no middle ridge, but has at the farther end of the cavity a hole about 2 in. square, with a stopper serving as a vent.

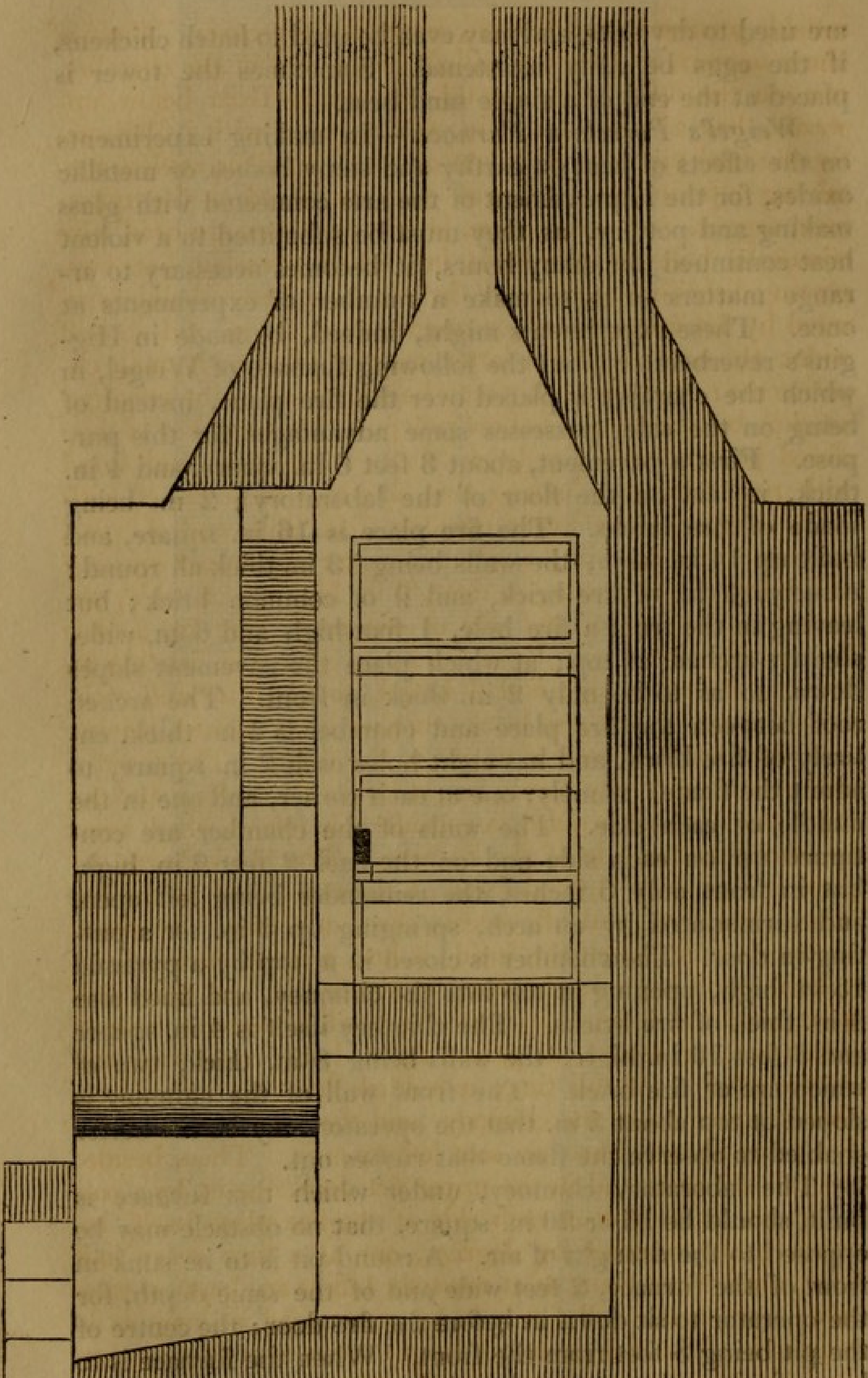
To use this furnace, a few lighted pieces of charcoal are let down the tower, which is then filled with charcoal and carefully closed at top by an air-tight stopper. Sometimes the upper part of the tower above the sand heat is an hollow frustum of a cone formed of cast iron, 12 in. diam. at bottom, and only 10 at top, which has a double rim round it; the intermediate space contains water or quick silver; into this the cover fits, and is thus accurately closed: and this construction has also this advantage, that there is no danger of the fewel sticking so as not to supply the fire, which is regulated by the admission and exit of air through the various registers. Cement pots may be placed in the muffle, or even ash hole; and bolt heads, sublimers, and other vessels, in the sand heat. The hot closets, having doors fitted to them,



are used to dry salts, and may even be used to hatch chickens, if the eggs be daily moistened. Sometimes the tower is placed at the end of a single sand heat.

Weigel's Porcelain Furnace.—In making experiments on the effects of heat on earthy and stony bodies, or metallic oxides, for the improvement of the arts connected with glass making and pottery, as they must be submitted to a violent heat continued for many hours, it becomes necessary to arrange matters so as to make a number of experiments at once. These experiments might, indeed, be made in Higgins's reverberatory, but the following furnace of Weigel, in which the chamber is placed over the fire place, instead of being on the side, possesses some advantages for this purpose. First a pavement, about 3 feet 6 in. square, and 4 in. thick, is laid on the floor of the laboratory; 2 in. being made of fire bricks. The fire place is 16 in. square, and built up 14 in. high, the walls being 13 in. thick all round: namely, 4 in. of fire brick, and 9 of common brick; but leaving in the front a fire hole, 1 foot high and 6 in. wide, slightly arched at top; at which place the pavement slopes down, so as to be only 2 in. thick in front. The arched roof between the fire place and chamber is 4 in. thick, entirely of fire brick, and has eight holes each 2 in. square, to admit the flame: namely, one at each corner, and one in the middle of each side. The walls of the chamber are continued up on each side and on the back 2 feet 2 in. high, but in front only 6 inches, the remainder being left open, and surmounted by an arch, springing up 3 in. for a putting-in door. The chamber is closed in at top by a pyramid 13 in. high, opening at top into the chimney, and lined also 4 in. thick of fire bricks. The chimney itself is 4 in. square and 3 feet 10 in. high; the walls being 8 in. thick, two of which are of fire brick. The front wall of the chimney is sloped at top about 3 in. that the operator may be the better enabled to observe the flame that rushes out.

The laboratory chimney, under which this furnace is built, should be 16 or 20 in. square, that no obstacle may be opposed to the draught of air. A round pit is to be sunk in front of the furnace, 2 feet wide and of the same depth, for the operator to sit down in before the fire door; the centre of the pit being 3 feet from the front. When the furnace is to be used, the substances to be tried are inclosed in cylindrical earthen boxes of porcelain half an inch thick, 12 in. diam.,



outside measure, and 6 high, including the cover. Four of these seggars, as they are called, are placed in the chamber, one on the other; the second, reckoning from below upwards, has a hole about 2 in. square, even with its bottom, for the trial pieces to be taken out at. Small crucibles, containing experimental mixtures, may be placed on the uppermost seggar. In some cases, hollow cylinders are used with triangular holes in their sides, into which porcelain bars supporting dishes or crucibles are thrust; the cylinders being separated by flat cakes, round or square, about 12 in. and an half wide; the corners of the latter may be filled with small experiments: or similar cakes may be supported at the required heights by short thick hollow pillars. The chamber is then closed in front with fire bricks fitting very close, and luted with porcelain clay, leaving two openings to be closed with brick stoppers; the lower opening 4 in. high and 2 wide, opposite to the hole in the second seggar: the upper opening at the top of the putting-in door, 3 in. high and 2 wide, opposite to the top of the pile of seggars. The fire door is then partly closed with three bricks on each side, leaving an opening 9 inches high and 3 broad, to admit air and withdraw the ashes; on these bricks another is laid across, leaving an arched opening over it to put in the fewel. The fewel is either fir or very dry beech, cut in billets 12 in. long and not more than an inch square, a considerable pile of which must be placed on the side of the furnace. The fire is begun by putting a piece of lighted wood on the cross brick of the fire door, then two, and afterwards three at a time. In about an hour's time, when the inside is hot, a single piece of unlighted wood is put in the door, increasing a piece every half hour, until the seventh or eighth hour, when twelve or sixteen pieces will, of course, be placed there, lying cross ways one on the other. At this time, a reddish flame six inches long should come out of the chimney, and the hinder part of the fire place should have no soot left upon it. Then, besides the billets before and in the upper fire door, one is, by a pair of tongs, to be put on each side of the fire place itself, increasing the number by degrees, one at a time every half hour, until three, four, or at most six billets are kept on each side; and thus a full fire is to be maintained as long as is required. The fire is at its height when the flame seems doubtful whether to go into the fire place or not; for that is a sign that the chamber is as full of flame, as can be taken off by the chimney, which has only half the area of the holes by which the flame enters the chamber. At this time, the flame from the chimney should be very white, tremulous at top, four or six feet long, with a roar audible at ten or more paces from the laboratory. The glowing wood, that ceases to flame, and the ashes, must be carefully extracted: and the trial pieces taken out every hour, or every two hours, to inspect the progress of the work. Eight hours' full fire is judged sufficient to burn common bricks and pottery; 24 hours' full fire changes common clay into a dark-coloured glass, and burns tobacco-pipe clay and steatite so that they strike fire with steel; 36 hours' full fire is required for burning the best porcelain, and by this heat, thus continued, both lime and gypsum are reduced to glass. The burning being finished, the fire is then to be lowered, by putting the billets lengthways in the fire hole, and when the flame has ceased and no smoke appears, the furnace is closed up. After a few days the fire hole is first opened, and a few hours afterwards, the putting-in door is also opened, that the seggars may be taken out.

Cold Still.—The cold still, as our good matrons of former days called it, alone remains to be noticed. It was, until lately, to be seen in every pewterer's shop. A trivet of iron supported a shallow iron dish or basin, about 4 inches deep and 12 wide, having a small hole cut in front about 3 in. square, and nearly even with the bottom; within this hung another, equally wide but very shallow, dish of pewter, about an inch deep; and to this was fitted a large conical head of pewter, rising up 18 or 24 inches high, with an internal channel at bottom, to direct the condensed vapour towards a projecting beak or nose, under which a bottle was placed. When used, some wood ashes were put into the iron dish, on which was laid an ignited cake of turf, which was then covered more or less thick with wood ashes; over these the pewter dish was suspended, on which were strewed fresh gathered herbs, flowers with the morning dew upon them, or any thing that it was wished to distill with a very gentle heat: upon these were placed a pewter plate with a weight upon it, and the whole covered with the large conical head. In some cases, an old jelly bag, with the point cut off, was dipped in water and drawn over the head, that the cold produced by evaporation might assist in condensing the vapours. In this way were produced the rose water and rose cake of our ancestors, the all-flower water from fresh cow dung, and many others. Turf has an advantage over other fewel, in that, being lighted, it will continue burning in a slow, equable manner, until it is entirely consumed, and yield more or less heat, according as it is buried to a less or greater depth in ashes. This furnace seems peculiar to us and the Dutch, the French using a bath of water, steam, or sand, for these distillations; of late, however, Guyton de Morveau has vaunted these low wide-mouthed stills, as a new discovery and improvement; but in hot stilling the liquor throws up globules, which are apt to pass over and spoil the product, and the use of an evaporating surface, instead of a refrigeratory or worm tub, has also been again brought forward as a new invention.

Some other practices of the old chemists, connected with the application of heat, have been also recently proclaimed as new and important discoveries. One is the forcing the vapours of distilled substances to pass through ignited tubes, a method practised some centuries ago by Raymund Lully, as may be seen in his work entitled, Experimenta. Another is the mode used by Glauber to condense the vapours disengaged in distillation, by inserting a bent pipe into the receiver, by which the uncondensed vapour is carried to the bottom of an intermediate receiver, half filled with water, and what is not absorbed is transmitted along a second bent pipe, inserted into another orifice in the intermediate or second receiver, into a third receiver. As also his contrivance to allow the passage of elastic fluids, or air disengaged in distillation, out of a close receiver, or the passage of the atmospheric air into it, by means of a twice bent pipe, having a liquid which serves as a stopper in the bend; an apparatus now known in England by the name of Welther's tube of safety, that French bleacher having, as usual, claimed the discovery, which, in fact, means only the introduction of any thing into France; the arts and knowledge of the gros esprits du Nord, being considered as lawful plunder for the members of la grande nation, to whom, in their vain conceit, belongs the earth and all that it contains. Glauber, in his book on furnaces, also exhibits the method of closing vessels by a double rim round the opening, the intermediate space being filled with some liquid, into which the cover is received.

Electrical Machine.—Allied to heat is the application of electricity, which produces effects of a similar nature, yet sometimes such as cannot be produced by fire alone. For the exhibition of ordinary electricity, a plate machine is used, formed of a circular plate of glass, turned on its axis, and made to rub against one or more cushions of leather, stuffed with horse hair and smeared with amalgam of zinc; the electric fire, as it is vulgarly called, being conducted to the required points by metal wires. But the discovery of galvanism has rendered electricity of little regard in chemistry, except for firing inflammable gases by the electric spark.

Galvanic Apparatus.—For that modification, or combination of the electric fluid, which is called galvanism, a very different apparatus is necessary. The simplest form is Volta's pile. A number of plates, for instance, penny pieces of copper, are arranged in two piles, in pairs with plates of zinc of the same diameter, each pair having a circular piece of flannel, moistened with the brine of common salt, or a weak acid, placed between them. In the one pile, a plate of copper forms the bottom piece, and one of zinc the top; in the other, this arrangement is reversed. The bottoms of the piles are connected by a wire, and the galvanism is applied to the subject on which it is to act, by wires from the two summits. On touching these summits with the hands a smart shock is felt. But the most advantageous mode of producing galvanism is the chain of cups. A number of glass jars, tumblers, or preserve pots, are arranged in a row, or a long trough of earthen ware, divided into cells, is procured. Plates of zinc are suspended from a wooden rod, with as many plates of copper which are bent up so as to inclose each zinc plate, on the two sides at a small distance. The copper plates are connected at top by a tongue with the zinc plate of the next pair. The pairs of plates are so far apart, that when the rod is depressed, a pair is plunged into each jar or cell, which are to be previously filled with a mixture of nitric acid, diluted with three times its weight of water; for common experiments a more dilute acid may be used. And the galvanic action is applied to the subjects by means of two wires, the one being connected with the zinc plate of one end, and the other with the copper plate of the farther end.

Theory of Chemistry.—The causes that give rise to the changes produced by chemistry, have been diversely explained; and such is, indeed, the recondite nature of the subject, that it does not seem probable that mankind will ever arrive at a complete knowledge of these causes, at least, while in their present state of existence. There is every reason to think, that the sublimest speculations of human wisdom, as conceived by the most subtile of men, may, and do appear to superior beings, intermediate between us and the Creator, weak and completely erroneous. Indeed, the hypotheses invented by philosophers, although dignified by the name of true theories, are to be considered as mere crude deductions from facts considered in a particular point of view; while another observer, considering the same facts with another view, may deduce another hypothesis, very different from the first, yet equally true so far as it goes.

Mechanical Theory of Matter.—Chemists seem never to have doubted the existence of matter, and, of course, never to have supposed, that the phenomena of the visible world are merely ideas existent only in our minds, or reflected from the Deity, according to the hypothesis of Vyasa, Berkeley, Malebranche, and others; although, in respect to the material substratum of the universe, both the two opinions that have been started still continue to have their respective partizans. According to the first class of philosophers, the ultimate portions of which material bodies are composed are identical in their nature, absolutely hard and unchangeable; when brought near together they attract, or endeavour to approach each other, with a force that increases as they approach nearer; but at a certain distance, the attraction becomes weaker and weaker, until at length a repulsive power succeeds, by which they repel and would fly from each other to the utmost bounds of space, unless some way hindered: the various properties of bodies depending upon the figure and size of the particles into which these atoms are congregated in the first instance, and the changes producible in them, depending on the alteration of the particles by the collision of the particles of other bodies, which either grind down the original particles smaller, or coalesce with them, or alter their figure, so that the body acquires new properties. This mechanical mode of explaining chemistry, was adopted by Boyle in his Sceptical Chemist, and various other works; by Newton, in the Queries affixed to his

Optics; by Friend, in his Chemical Lectures; as also, but in a very inferior manner, by Lemeri, in his Course of Chemistry. Two famous experiments have been supposed to prove this doctrine: the earth that seems to be produced from water, by repeated distillation in glass vessels, and the growth of vegetables, apparently from water alone. But more careful experimenters have found, that the earth is derived from the vessel, as is shown by the weight it loses. The latter experiment is equally delusive, for Woodward has shown, that vegetables grow very slow in pure water, but quickly in water loaded with mould; and it is well known to gardeners, that sun light is necessary to develope the oily juices of plants, which otherwise remain watery and insipid, while the nature of the circumambient atmosphere, and its agency in vegetable life, were neglected and indeed unknown.

Chemical Theory of Matter.—The other hypothesis respecting the nature of matter in general, is, that its nature is not perfectly similar throughout all its parts, but that bodies are composed of a small number of elements, as words are of letters, the atoms of each element being similar and identical with one another, but differing in properties from those of the other elements: the properties of the atoms of each element being immutable, totally independent of size or figure, preserved unchanged in all their combinations with the atoms of other elements, impressing more or less their own characteristic differences upon the combinations into which they enter, and again appearing with all their original properties when separated. On this hypothesis, the changes produced by the action of bodies on each other, arise from the alteration that takes place in the elementary composition of bodies, one or more of the elements being transferred from the one body to the other, or a mutual exchange of part of their elements taking place between them.

Affinity.—These transfers of the elements from one combination to another, have been ascribed to two causes. The first explanation was, that the atoms of each element have each of them a determinate tendency for uniting with those of some one of the other elements, rather than with those of some other, and being placed in contact with the atoms of several other elements they unite with those for which they have, in the metaphorical language of the ancient philosophers, the greatest love; or, as the moderns express the same idea, the greatest degree of elective attraction. And, it being further supposed by some, that the election took place, as implied in the common proverb of the social preferences existing amongst mankind, that like loves like, the cause that determined these transfers was denominated affinity; it being supposed, that any similarity existing in the chemical properties of the elements, naturally led to their union, in preference to the union of either of them with elements that differed very considerably from them. How could the favourers of this opinion overlook the most common phenomena occurring in the practice of chemistry, the union of acids with alkalies, two classes of bodies that differ considerably from one another, and yet form combinations very intimate and very permanent?

Causes of Combination and Separation.—The researches of Berthollet, Dulong, and others, have shown, however, that the usual elections by which combinations are formed, and transfers of the elements take place, are influenced and controlled by other causes, as by the influence of mass; it being well known how difficultly the last portions of one substance are separated from another, as in the drying of some salts. Secondly, by the power of cohesion, as pulverulent alumine is easily soluble in a solution of potash, which has no effect upon the aluminous gems: or, when two or more of the elements are disposed to form a solid compound, which separates from the remaining liquid, as when the solution of barytes in nitric acid, is added to a solution of Glauber's salt in water; when the sulphuric acid of the Glauber's salt unites with the barytes of the other solution, and forms a compound, which being insoluble in the water that is present, separates in a pulverulent form, leaving the nitric acid to unite with the relinquished soda of the Glauber's salt and with the water. Thirdly, the opposite case of the formation of a gaseous or aëriform fluid; as when carbonate of ammonia is added to a solution of lime in spirit of salt, in which case, carbonate of lime is thrown down, the carbonic acid quitting the ammonia and forming an insoluble compound with the lime, while a solution of sal ammoniac is left, the muriatic acid of the spirit of salt, separated from the lime uniting with the relinquished ammonia, and remaining dissolved in the water; but if this solution is boiled, the volatility of the ammonia, or its attraction and union with caloric, that is to say, the matter that is the most frequent cause of the sensation of heat, forms a gas which separates from the liquid, and the carbonate of lime is then dissolved.

Analysis by Heat.—In all the cases here quoted, and indeed in all operations, it is the union of two or more of the elements, that determines the separation of the remainder; although, in the case of the union of heat (if it be a species of matter) determining the separation of one or more elements of the mixed body, by first rendering them volatile, and then, in consequence of its tendency to diffuse itself equally throughout space, leaving them and permitting them to condense, there is no permanent union. Thus, if a solution of common salt in water is gently heated in close vessels, the heat uniting with the water causes it to assume an airlike form, and change its name to steam, which passing over into the receivers, the heat leaves it, the steam is condensed, and again assumes the form of water, leaving the salt behind in the distilling vessels. Sometimes part of the heat or caloric, as the material cause of heat is more usually called at present, remains united with some of the separated elements: as when lime stone is exposed to a great heat in close vessels, the caloric unites with the solid carbonic acid of the lime stone, which leaves its other component part the lime, and is volatilized; but the carbonic acid does not part with the whole of the caloric by cooling, for some of it remains united, although not perceptible by the thermometer, and forms carbonic acid gas. In like manner, calcined quick silver, called by the old chemists mercury precipitated per se, and by the later the red oxide of quick silver, which is most generally supposed to be composed of quick silver and solid oxygen, is decomposed on being heated; the oxygen uniting with heat, is volatilized and assumes the form of oxygen gas, while the quick silver, being also volatilized, passes over the helm and assumes its usual liquid form.

Operating Viâ siccâ and Viâ humidâ.—These transfers seldom take place unless the bodies, or at least one of them, are in the form of a fluid, and operations are said to be performed the dry way, when this fluidity is produced by the agency of heat; and the moist way, when water is the fluid that holds the active bodies in solution, and thus enables them to act upon each other. For an example of the former, the common assay of potter's lead ore, which is a natural combination of lead with sulphur, may be used: the bruised ore is melted in an iron dish, when the sulphur of the ore combines with the iron of the vessel, leaving the lead over which the sulphurated iron swims, and thus protects the lead from calcination. For an example of the moist way, in which a simple transfer takes place, the addition of spirit of salt to a solution of silver in aqua fortis, may be chosen. In this case, the muriatic acid of the spirit of salt unites with the oxide of silver, and forms a curd called Luna cornea, which is a muriate of silver, while the nitric acid that held the oxide of silver dissolved, is set free.

Elements.—Chemists have not agreed on the number of the elements into which bodies may be chemically divided, principally on account of the different value set by the various schools upon analogical reasoning, which some would reject entirely, unless it be on such subjects as may contribute to their individual fame, or that of their teacher, to whose ipse dixit some modern chemists bow with a reverence which was not found, perhaps, even in the disciples of Pythagoras, approaching indeed, or rather reaching to idolatry. Another cause of discrepancy in the notions of the chemists respecting the elements is the dispute whether any elements exist which are so very light, that, when combined with other elements, they make no observable addition to the weight of the body. Those that maintain their existence observe, that the limits of density between those that are cognisable by the balance are very great, platina being 253872 times as heavy, in the same bulk, as hydrogen gas, and we have no reason to suppose, that gases lighter than hydrogen gas do not exist: now, as a gallon of hydrogen gas weighs less than five grains Troy, it is therefore evident, that from the imperfection of our balances, a gas as many times lighter than hydrogen, would not add any perceptible weight to that of the vessel in which it was contained, or to the weight of the other elements with which it was combined; and the extreme rarity of some of these fluids, will account for their incoercibility in vessels, and for the transmission of the rays of light, or, on the other hypothesis of illumination, of the pulses of that subtle element, through dense transparent media.

Unweighable Elements.—The elements not cognisable by their weight, which have been considered necessary to explain the phenomena of chemistry, are:

1. The matter of heat, called by some caloric, which is considered as uniting with the molecules, or those ultimate divisions of a body in which each division retains the nature

of the whole, in two different manners; first, as latent heat, not affecting the thermometer, but combined, as it were, chemically, with the other body, causing it to assume a fluid form, either dense as water, or elastic as air; which forms, in conformity with the other parts of the cant slang so much used by the chemists, in spite of the ingenious rallyings of Butler in his Hudibras, and Ben Jonson in his Alchemist, and the sober reasoning of Robinson in his Notes to Black's Lectures, might be denominated the protothermate and deutothermate of the substances so melted, or reduced to vapour or gas; as water might be called the protothermate of ice, and the atmospheric air the deutothermate of air. Indeed, Sertunner and some German authors use the terms thermate of hydro-oxide for water, thermate of light-oxide for oxygen gas, and many similar phrases. Secondly, as thermometric heat, which resembles the water of crystallization in salts, and does not form an essential part of the composition of the body into which it enters. Black has supposed, that ductility and softness depend upon a portion of caloric retained by the particles of bodies; from whence he explains the heat that is evolved, and the brittleness acquired by copper, and some other metals, when suddenly compressed by quick hammering or a screw press.

2. Cold has been supposed by some, to be owing to the absorption of a certain frigorific matter; but is more generally thought to be the mere diminution of heat.

3 to 9. Light, or the matter that is supposed to be the principal cause of the phenomena of vision and illumination: it is the substance, to which the old English alchemists attributed the ductility of metals, under the name of spirit, and which some chemists suppose to be the principle that is the cause of combustibility. As the illuminating rays of the sun can be divided, by transmission through transparent bodies of a certain form, into pencils of seven different colours, namely, red, orange, yellow, green, blue, indigo, and violet, they have been supposed to be a compound of seven, or at least three different substances: the red, yellow, and blue rays, to which some add the violet, which are evolved independently of each other in certain chemical operations, and have different chemical actions upon certain substances. Besides these rays, the prismatic spectrum has been found to contain two other kinds of rays: one communicating heat, and called calorific rays, which are more abundant at the red

end of the spectrum; the other separating oxygen from its combinations, and hence called the deoxidizing rays, these last being most abundant at the violet end: but some consider these operations as mere variations in degree of the properties of the colorific rays.

10. Fire. The ancients esteemed this as a principle of bodies, but it is more generally supposed, at present, to be a combination of heat and light, streaming out simultaneously from ignited substances. A modern author seems to ascribe to flame the properties of fire, which, however, appears to be only the volatilized ignited molecules of the burning body.

11, 12. Electricity, or the electric fluid: first noticed from its causing light bodies, as scraps of paper or ashes, to be taken up at some little distance by amber, which is called in Greek electron. It differs greatly from caloric in regard to the extreme quickness with which it passes through metals and water, and the resistance offered to its passage by glass, rosins, and some other substances; by which means, bodies impregnated with it may be insulated, and made to retain it in excess for some time, or, contrariwise, be prevented from acquiring their natural charge. The original theory supposed there were two fluids of this kind: 1st, the vitreous, which may be produced or pumped from the surrounding conductors by the rubbing of glass with woollen cloth; and 2nd, the resinous, which may be produced or pumped from the surrounding conductors by the rubbing of rosin with cloth. The friction of bodies together, melting, evaporation, fracture, or the mere contact of different bodies, are the means of exhibiting the presence of the electric fire, as it is sometimes called, by causing its accumulation. There are others, who contend for the identity of the electric fluid, and ascribe the phenomena of the vitreous electricity, to the accumulation of the fluid; and of the resinous, to a deficiency in that place of the natural quantity; hence they denominate the first, plus, or positive electricity, and the other minus, or negative electricity. Some will have electricity to be a combination of oxygen with azote.

13. Galvanism, Voltaic electricity, or the galvanic fluid, differs little in its general habits from electricity, but is produced in the oxidation of metals by weak acids, or even by water. It has of late been considered as a combination of the electric fluid with caloric, and by some, as a combination of oxygen with hydrogen.

14, 15. Magnetism, or the magnetic fluid, has long been supposed to be some way connected with the electric, and it now appears to depend, in most cases at least, on the direction of the current in which the electric fluid or fluids pass through the magnetic needle, or the globe of the earth. Some have conceived the existence of two different magnetic fluids, analogous to the two electricities, which they call the boreal and the austral fluid.

All the above unweighable elements, when sufficiently concentrated, are visible to the human eye, the aurora borealis being certainly the visible appearance of the accumulated magnetism of the earth at its poles. Except magnetism, and this exception is perhaps erroneous, they also produce, on concentration, the phenomena of increasing the temperature of bodies. Hence many, even of those who contend for their materiality, have ascribed all the phenomena they exhibit to the agency of one single fluid, under the name of ethereal matter, or radiant matter; while others deny their materiality altogether, and ascribe the phenomena to the vibrations of the particles of bodies and the projection of some part of them by the violence of the vibration. It is, indeed, true, that friction of hard bodies together will produce a considerable increase of temperature, but caloric is transmissible through all bodies yet known; and hence, as there are no means of insulating the bodies thus rubbed together, it cannot be affirmed, that the caloric, to produce this increase of temperature, is not extracted from the circumjacent substances, in a manner analogous to the extraction of the electric fluid. And may not the phenomena of heat and illumination be produced in two ways, chemically and mechanically, as seems to be the case with electricity, galvanism, and magnetism?

The aëriform state of bodies was ascribed by Bryan Higgins to a principle of repulsion, inherent in the atoms of certain elements, by virtue of which, they repelled each other, unless this repulsion was overpowered by the attractive force of the atoms of the other elements.

Weighable Elements.—In respect to the elements whose presence is cognisable by their weight, there is less discrepancy among chemists; although they do not agree entirely on the subject, and probably never will. That bodies, similar in their appearance and properties, should be composed of similar elements, is an opinion that has been held from the most ancient times, and seems, indeed, to be an innate idea in our minds; and therefore, as we probably never shall be able to demonstrate this identity of composition in every instance, those chemists that will see nothing but what they can put into the scales, will ever be of a contrary opinion to those who prefer the dictates of common sense to that stern decree of Epicurean philosophy.

The most simple weighable substances which the chemists have as yet been able to obtain, are as follows; arranged into classes according to their supposed composition, as conceived by the rationalists.

Oxygen.—The first class contains only one body, namely, oxygen, which, when separated from bodies, is so volatile as always to appear in the form of a permanent gas, called at present, oxygen gas, but formerly, dephlogisticated air, empyrean air, fire air, and which has been also called the acidifying principle. Its powers of action are so great, that very few natural bodies exist in which it does not form a constituent part; but its separation from the next class does not arise solely from this superior activity, but from its being always attracted by the positive pole of a galvanic apparatus, and separated there when any of the combinations into which it enters, are decomposed by the action of galvanism or electricity: hence some, who conceive water to be an element, suppose oxygen gas to be a combination of water with the resinous electric fluid. Lavoisier, from the phenomena of combustion, in which the flame appears to surround the burning body at some distance, supposed this flame to arise from the extrication of light from the oxygen gas, and that this gas was, in fact, as it is called by Sertunner, a combination of oxygen with light, or, in strict language, an oxide of light; but as this was only shifting the phlogiston of Stahl from the combustible body to the air, Lavoisier dextrously slurred over this point, and his theory is still erroneously denominated the antiphlogistic, by unwary authors.

Oxides.—The combinations of oxygen with other simple bodies, are called at present by two names, according to the properties they exhibit. When the charge of oxygen is not sufficient to communicate those properties which go by the name of acidity or sourness, the compound is called an oxide, as oxide of iron; or oxide is used as a termination, as hydrogen-oxide, or, by a contraction, hydroxide for water. As oxygen combines in several various proportions, there is a necessity of distinguishing these different oxides. They are sometimes distinguished by their colours, as black oxide of iron, red oxide of iron: sometimes the proportions are made the ground of the distinction, and they are called, 1st, the suboxide, 2d, the oxide; or—1st, the minor oxide, 2d, the major oxide; or—1st, the oxide, 2d, the superoxide; or—1st, the protoxide, 2d, the peroxide; or—1st, the ferrose oxide, 2d, the ferric oxide. But oxygen is frequently combined in more than two proportions, and yet is not complaisant enough to vary in colour, or form an acid: hence arises a necessity for fresh terms, which are taken from the Greek numerals: 1st, the protoxide, for that which contains the least, 2d, deutoxide, 3d, tritoxide, 4th, tetroxide, and 5th, the peroxide, for that which holds the greatest charge.

Acids.—When the combination possesses the properties of a sour body, it is called an acid; and here, as these acids admit different charges of oxygen, they are distinguished by their ending, as phosphorous acid and phosphoric acid. When only one acid is known to be formed by union of oxygen with this basis, some chemists use the adjective in *ous*, others that in *ic*. The gas formed by distilling muriatic acid upon black oxide of manganese, being supposed to contain more oxygen than its parent, was distinguished by prefixing oxy to the adjective, and called oxymuriatic acid gas. With sulphur, oxygen forms no less than four acids; these have been distinguished by prefixing hypo to the adjective denoting the next greater charge of oxygen: 1st, hyposulphurous acid; 2d, sulphurous; 3d, hyposulphuric; 4th, sulphuric. The hypo seems to have been chosen by the French authors instead of sub, as having a more *learned* sound, and conveying an idea of Grecian lore, a much more rare accomplishment in France than in England; French vanity overlooking the monstrous absurdity of hybrid words, half Greek and half Latin, with barbarous terminations tacked to their tails.

Berzelius has lately introduced the use of the term superoxide, for those combinations of oxygen in which the excess of oxygen masks the acid character: as muriatose superoxide, for what some call chlorine; muriatic superoxide, for euchlorine; iodic superoxide, for iodine.

The inconveniency, however, of having two words, oxide and acid, to express the combinations of the same element, is one of the departures from the strict principles on which the new nomenclators pretended to act; and it would be far better to drop the use of the word acid as a denomination expressive of composition, and retain only oxide, prefixing appropriate adjectives, expressing either their properties or proportional charge of oxygen; and this the more especially, as the same substance sometimes acts the part of a base, and sometimes of an acid.

Nomenclature of Salts.—Acids, in consequence of their containing so much oxygen, partake of its activity and power of combination; and, as oxidated bodies combine only with one another, because, if either of them were not already combined with that element, the oxygen would divide itself between them both, it is usual to omit all mention of it in naming the salts thus produced. The combinations of the ——ous acids, are named ——ites; and the combinations of the ——ic acids, are named ——ates of the different simple substances: as phosphite of potasse, phosphate of potasse, sulphite of iron, sulphate of iron: in which it may be remarked, that phosphorus and sulphur, as also tungsten and tartar, have as usual, in a cant slang, been robbed of one of their syllables, in forming these words. The case is the same with respect to molybdic acid, from molybdena, with the additional circumstance of an equivocation; for molybdos being the Greek name of lead, the molybdic oxide or acid is literally the oxide or acid of lead. Saccharolactic acid, as it should etymologically be written, is deprived of two syllables, and its adjective reduced to the unmeaning word saclactic; while for its combinations, saclactate is used.

When an acid combines in two different proportions with the same base, this is expressed in various ways: as, 1st, acidulous sulphate of potasse; 2d, sulphate of potasse;—or, 1st, supertartrate of potasse, the mystic name of argol, or the tartar of wine; 2d, tartrate of potasse, called in plain English soluble tartar;—or 1st, sulphate of alumine; 2d, sulphate of alumine with excess of base;—or, 1st, sulphate of copper, known to most people by its proper name of blue vitriol, or blue stone; 2d, subsulphate of copper;—or, 1st, oxalate of potasse, containing the smallest possible quantity of oxalic acid to a certain quantity of potasse; 2d, binoxalate of potasse, containing twice as much acid to the same quantity of potasse; and 3d, quadroxalate of potasse, containing four times as much acid.

These denominations suppose the oxide to contain the same proportion of oxygen throughout; but we have stated, that there are various oxides of the same substances, each of which, speaking in general, are combinable with the same acid; hence arises a necessity for distinguishing them. Of course the chemists speak of, 1st, green sulphate of iron; 2d, red sulphate of iron;—or, 1st, sulphate or protosulphate of iron; 2d, oxysulphate or persulphate of iron: a most ridiculous mode, to alter the name of the acid to express an alteration in the substance with which it is combined; or, 1st, submuriate of mercury, well known by the name of calomel; 2d, muriate of mercury, equally well known as corrosive sublimate; which, besides the absurdity just noticed, is in this case dangerously equivocal, as some chemists have called calomel, muriate of mercury, and corrosive sublimate, oxymuriate.

Sometimes two acids are combined with the same oxide; a combination expressed thus, nitromuriate of gold. But it is more usual to find two oxides combined with the same acid, and there is an equal diversity in enunciating this union of three substances. Some join the two oxides to form a compound word expressive of the base, considered as a simple: as tartrate of potasse-and-antimony, well known as emetic tartar; when the hyphens are omitted, the name becomes equivocal, as it may signify two distinct substances. Others prefix the name of one of the bases to that of the acid: as soda-muriate of platinum, and thus appear to consider one of these combinations as a compound acid, which is, perhaps, the truth, and certainly less liable to mistake.

Thermoxygen.—It has been already stated, that when a body is in the state of a gas, it is combined with a large charge of caloric, or the matter of heat. This is usually supplied by the application of burning fewel to the substances from which it is to be extricated, by which it gradually assumes that form, as it absorbs the caloric; hence the sudden absorption of a gas by a dense body, or the mutual condensation of two gases into a dense body, usually produces a considerable increase of temperature; and, on the other hand, the sudden evolution of a gas diminishes the temperature very considerably. But this is not always the case; for, when gunpowder and some similar compositions are fired, the gun barrel, notwithstanding the solid combustible is momentarily expanded into a voluminous gas, has its temperature considerably increased. To explain this singular phenomenon, Brugnatelli conceived, that oxygen entered into combination in two different states; sometimes in a pure state, which he designated by the term oxygen; and at others, as in salt petre, carried along with it a full charge of caloric, chemically united with it, to which the explosive nature of gunpowder, &c. was due, and from whence arose the heating of the gun barrel; and this he distinguished by the name of thermoxygen. He therefore distinguished the combinations by two different names, using oxide and acid for those in which oxygen enters in a simple state; and thermoxide, and thermacid, for those into which thermoxygen entered. It is evident, that some supposition of this kind is required, to explain the phenomena; for, on the common theory, the gun barrel should have its temperature so greatly diminished by the caloric to be absorbed from it, in order to form the gases which cause the explosion, that repeated firings should encrust it with a coat of ice, and produce a heavy fall of snow in the neighbourhood, and soldiers and sailors, instead of having hot work in a battle or attack, should shiver with cold. Hence, a sceptical chemist, who considers the subject, must be highly amused at the slighting manner in which this hypothesis of Brugnatelli is mentioned, even by those who believe in the materiality of heat, and who are ready to give credit to the crudest suggestion of a French academician. We are gravely informed, that there is no other proof of this hypothesis, but that it explains the phenomena. What other proof have we of the truth of any theory, but its accordance with facts? Instead of this slight mention of an ingenious hypothesis, to which its opposers allow the merit of explaining the phenomena which their own does not, the acute intellect of the Italian authors, so superior to those of the other European nations, should alone have secured it more attention; and this the more especially, as Brugnatelli was a Professor at one of the four intellectual cities of Europe, the seats of modern knowledge; and no whit inferior to any of the others, whether Edinburgh, Jena, or Geneva, but that its language is less known to our scientific men. It were to be wished that we bestowed the same attention on Italian literature and science that we formerly did in the golden age of our own literature, instead of lending ourselves to chant the praise of our vain-glorious neighbours, who want no assistance in trumpetting their own merit; and who have so mainly contributed to give chemistry its death blow, by turning the attention of the students from the acquisition of facts, to the subtilties of an ever-changing nomenclature: and this too frequently done at the expense of our own countrymen's honest and well-earned fame.

Metallic Elements.—The second class of simple bodies, cognizable by the balance, is very numerous, and comprises the following substances:

1. Antimony metal; by those using the Lavoisierian nomenclature called simply antimony, which denotes in common language, a combination of this metal with sulphur.

2. Arsenic metal: by the chemists who assume to themselves the title of scientific chemists, called simply arsenic, which is the proper name of what some of them call the white oxide of arsenic, and others the arsenious acid.

3. Barium, or the metallic substance obtainable from cawk, by operose processes: as it is rather light, Clarke calls it Plutonium.

4. Bismuth, or tinglass.

5. Boron, or the peculiar combustible substance obtainable from borax or tincar.

6. Cadmium; a metal obtainable from lapis calaminaris, and several other ores of zinc, particularly the black fibrous Bohemian blend.

7. Calcium, or the metal obtainable by galvanism from quick lime.

8. Carbone; a general term including several substances known by different names, according to their state of aggregation and production: as diamond, when crystallized, stone-like, and found in the strata of the earth; lamp black, when powdery and formed by burning oils with a long smoking wick, and collecting the smoke; which kind was supposed by Becher and Stahl to be the nearly pure combustible principle of metals, that the first called inflammable earth, and the second phlogiston. Charcoal is also frequently called by this name; the earthy and saline substances that form the ashes when burnt, and the hydrogen gas obtainable from it, being slurred over, as incommodious to the theory.

9. Cerium; a new metal lately obtained from two minerals, called cerite and allanite.

10. Chrome; a metal originally obtained from red Siberian lead ore, but now from the native chromate of iron.

11. Cobalt metal, obtained from cobalt; a mineral now used to colour glass blue; whence smalt, powder blue, and the blue colour of real and imitative Nankeen china. The

old German miners not knowing what to do with this ore, bestowed upon it their malediction, by giving it the name of cobalus; which, in their mythology, was an evil demon that haunted mines, and of whom they were so afraid, that a supplication was inserted in their litany for the assistance of God against him. Modern writers usually use the word cobalt for the metal itself, paying no regard to the equivocation thus introduced.

12. Columbium, or tantalum; a metal obtained from a Massachusetts mineral, and from Ekeberg's yttrotantalite.

13. Copper, or Venus, from its susceptibility of the action of almost every solvent.

14. Gold, or Sol, from its colour and pre-eminent value.

15. Iridium; a metal obtainable from the black powder left on dissolving platina in aqua regia, or nitromuriatic acid; so called from the variety of colours it exhibits when dissolved in spirit of salt.

16. Iron, or Mars.

17. Lead, or Saturn, from its great weight.

18. Lithium; a metal obtainable from the mineral called petalite.

19. Manganese metal; obtainable from manganese, which is an oxide of it. Most modern chemists use only manganese for the metal itself, not regarding the equivocality in English; as magnesia nigra is the Latin name of the oxide, the calling of the metal magnesium, is not liable to this censure.

20. Molybdenum, or the metal obtained from German black lead.

21. Nickel; a metal obtained from kupffernickel, another ore which fell under the curses of the German miners, who being tantalized with its appearance, so nearly resembling copper ore, bestowed upon it that opprobrious name, signifying the copper devil; Old nick being used as the proper name of the devil in Germany, as well as England.

22. Osmium; another metal obtainable from the black residuum left in dissolving platina. It takes its name from the strong smell of its oxide.

23. Palladium; a metal found intermixed with platinum in platina.

24. Phosphorus; a peculiar combustible substance obtainable from bone ashes.

25. Platinum; a metal forming the predominant part of platina, or smiris Hispanica.

26. Potassium, or kalium; a metal obtainable from potash by galvanic action.

27. Quick silver, or mercury; a metal remarkable for its fusing point being below the temperature of this country, and its being, therefore, always in a melted state. Quick is an adjective, seldom employed, but synonymous with living.

28. Rhodium; a metal found intermixed with platinum in platina: its muriate gives a rose colour to spirit of wine, whence its name.

29. Selenium; a peculiar combustible body, obtained originally from Fahlun pyrites, and since from an ore called seleniuret of copper.

30. Silver, or Luna.

31. Sodium, or natrium; a metal obtainable from barilha or kelp, by the action of galvanism.

32. Strontium; a metal obtainable from the heavy spar of Strontian, in Argyleshire.

33. Sulphur, or brimstone.

34. Tellurium; a metal obtainable from the graphic ore of Transylvania.

35. Tin, or Jupiter.

36. Titanium; a metal obtainable from the Hungarian red schorl.

37. Uranium; a metal obtainable from the pech-blende of Saxony.

38. Wolframium, tungstenum, or scheeline; a metal obtainable from wolfram.

39. Zinc, or spelter.

All these bodies are esteemed as simple in the present state of our knowledge, by the Epicurean school of chemistry, which makes the balance the decisive judge of their hypotheses; but the rational, or Aristotelian school, which pleads for a moderate use of analogy, is of opinion that they are compounds, in some measure analogous to the ordinary combustibles of the vegetable and animal kind; being composed of a base united with an element common to all of them, and which is supposed to be light, from the necessity of the sun's rays to give colour, and the usual degree of combustibility to plants, which are white and watery when deprived of its cheering influence, and hence are said by the French to be etoilée, as if they had grown by starlight; a phrase which has been baldly translated into our language by etoilated (misprinted in most books etiolated) instead of stargrown. They all unite more or less with oxygen, and when the union takes place quickly, heat and light are extricated. The generality of publishing chemists consider this as a simple union of the two bodies, and slur over the extrication of the heat and light, as troublesome to account for on their theory; but others take this emission into their consideration, and conceive, that one of these unweighable elements is separated from the metal or other body of this class. Those few chemists who hold water to be an element, and the only ponderable part of oxygen gas, must of necessity suppose the bodies produced by the action of oxygen on these bodies, to be combinations of them with water, either with or without the inflammable principle, as their hypotheses shall dictate.

The new-namesetting chemists have not been so busy with this class of principles as with the former. The combinations of boron are called borures or borurets of ——; of carbone, carbures or carburets; of phosphorus, phosphures or phosphurets; of potassium, potassiurets; of sodium, sodurets; of quick silver, amalgams, that is to say, marriages; those of the other bodies, which are called metals, with one another, are all confounded under the general title of alloys of —— with ——: but Berzelius has introduced into his writings the terms auretum, argenturetum, and the like, derived from the Latin names of the several metals: and Sir H. Davy has proposed to call the metals, when uncombined, by their Latin names, which end in *um*, and when oxidized to change this termination into *a*, as ferrum for iron, ferra for oxide of iron.

Earthy Elements.—The third class of bodies cognisable by the balance, which have not as yet been reduced to a simpler state, are the following:

1. Alumine; the earth that forms the basis of alum, and gives the predominant qualities to clays.

2. Glucine, or beryllia; an earth extracted from the emerald and aqua marina.

3. Silica, or rock crystal.

4. Thorina; an earth extractible from the gadolinite of Korarvet, and a few other minerals.

5. Yttria; an earth extracted from a stone found at Ytterby in Sweden.

6. Zirconia, or jargoon earth, as being extracted from the jargoon, which is called zircon by the Germans and those who translate mineralogical works from that language, without knowing, or at least attending to, the proper English terms.

The analogy between these earthy bodies and the oxides of the metals is so great, that they have always been thought to be related; hence the ancient chemists denominated the metallic oxides the earths of their respective metals. Lavoisier reversed the analogy, and instead of continuing to identify the metallic oxides with the earths, compared the earths to the metallic oxides; and, being a Frenchman, he of course claimed this mere shifting of the terms of the analogy, as a great discovery. Even the Epicurean chemists of the present day allow these bodies to be oxides, although they have not yet been able to exhibit the metals, which they call aluminium, glucinum, silicium, thorinum, yttrium, zirconium. As silica and alumine act in some minerals the part of an acid, these combinations are called siliciates and aluminates.

Elements of the fourth Class.—A fourth class, all of which have been discovered within our own memory, comprises only three substances, namely:

1. Azote, or nitrogen; formerly called phlogisticated air, or mephitic gas, is the residual aëriform fluid that is left when phosphorus is set on fire in a jar of common air.

2. Chlorine gas, called also dephlogisticated muriatic acid, oxymuriatic acid gas, and by Berzelius muriatic superoxide; is obtained from the action of spirit of salt upon manganese. Sir H. Davy distinguishes its combinations by the termination *ane*, as stannane; the chlorure, or chloride, of tin, according to others.

3. Iodine; a purplish substance, obtainable from the ashes of certain sea weeds.

All of these are esteemed by Sir H. Davy, Brande, and the chemists of that school, as simple bodies in the present state of our knowledge, but Berzelius and the rationalists consider them as oxides; the supposed bases of the two first being called by him nitricum, muriaticum, and that of the third may be distinguished by the name of iodium.

The phenomena, so far as ponderable matter is concerned, may be explained upon either hypothesis; on the other hand, were specimens of them, and their respective combinations, intermixed in their proper places, with a large and general collection of chemical productions, arranged upon the principle of the composition of the substances, they would, if inserted by the first hypothesis, be taken notice of by a mere casual observer, as having a very different appearance from their neighbours; and if by the second, they would pass unnoticed, as being in the company of their fellows. But, to lay no stress upon this similitude of appearance, the chemists must wait for the results to be obtained from examining and considering the passage of light through bodies, and other subtile researches respecting the action of ponderable and unponderable matter upon each other, provided that this investigation shall be instituted without any undue preference to either opinion, but that both sides of the question shall be duly examined to see which has the fewest anomalies. For, when unweighable bodies are concerned, the experience of all ages, and especially the supplanting Stahl's theory by that of Lavoisier, has shown us how easily an hypothesis may be constructed, and how boldly it may be maintained, when the consideration of the opposite hypothesis is dextrously slipped aside as if it had no existence, or a false and distorted picture is given of it; whereas, an unprejudiced examination will generally produce considerable hesitation in adopting either hypothesis, and usually tend to confirm the oldest.

Elements, fifth Class.—The fifth and last class of these supposed simple substances comprises only three species of matter.

1. Hydrogen, or light inflammable air; the lightest of all ponderable substances, and hence used to inflate air balloons for aërial navigation. Some conceive it to be a simple metal, which is vaporised and remains uncondensable in any temperature to which it has hitherto been exposed; others, as Scheele, that it is a compound formed of heat and phlogiston. Kirwan and Cavendish conceived it to be the common principle of all inflammable bodies, an opinion very erroneously ascribed to Scheele; while others have thought it a compound of water and resinous electricity; and there have not been wanting others, who conceive it a constituent element of galvanism, the other component being oxygen. Its compounds are called hydrures or hydrogurets; and as the essence of a canting language consists in curtailing words, its presence is sometimes denoted by prefixing hydro- to the other part of the name; the coiners of this slang paying no regard to this addition being used, and far more pro-

perly, to denote the existence of water as an element of the compound.

2. Water has from the earliest times been esteemed an element; but at present the generality of publishing chemists consider it as a compound of oxygen with hydrogen, and it ought, of course, to be called in strict language the oxide of hydrogen, or rather protoxide of hydrogen, according to one supposition, or suboxide according to another. Those that still retain the original hypothesis, consider water as the ponderable basis of both oxygen and hydrogen, and explain the apparent decomposition of it by the electric or galvanic fluid, on the supposition that the electric fluid is itself decomposed, the vitreous part combining with one portion of the water and forming oxygen, while the resinous combines with the other and forms hydrogen. On the other hand, when these gases are mixed, and an electric spark sent through the mixture, the two electric fluids are supposed to unite; heat and light to be separated or generated, and the water contained in both of them precipitated. The combinations in which water enters as a chemical element, are called hydrates, and are sometimes designated by the prefixing of hydro- to the other part of the name.

3. Fluoric acid; produced from fluor, or Derbyshire spar, by oil of vitriol in silver vessels. Analogy leads most chemists to consider it as an oxide of some unknown base, and therefore similar to azote or chlorine; but some conceive it to be a combination of this unknown basis, to which the name of fluorine or phthore is given, with hydrogen, and therefore analogous not to the oxygenous acids, but to muriatic acid, which they suppose to be composed of hydrogen and chlorine. A third party consider fluoric acid as an element itself.

Differences concerning the Elements.—Such are the various opinions of chemists respecting the substances to which natural and artificial bodies are reduced, by pushing their analysis to the utmost. The accuracy introduced into chemistry of late years by the assay masters, as Cramer, Klaproth, and others, in weighing the products and comparing their weight with that of the substances employed, has tended greatly to improve our knowledge in this respect. Common sense, however, leads mankind to place so much reliance on analogy in inferring a similar composition of bodies from a similarity of appearance and qualities, that a perfect accordance of opinion does not exist, even in respect to the principles which are weighable in the balance, although no subtile unweighable elements be supposed concerned; as we see in the different opinions entertained concerning muriatic acid. The generality of acids are formed of a combustible or metallic basis united with oxygen, and sometimes with more or less water. As chlorine gas, uniting with hydrogen gas, forms muriatic acid, analogy leads some to conclude that chlorine is a superoxide, part of the oxygen of which unites with the hydrogen and forms water, the other portion of oxygen remains united with the combustible or metallic basis, and gives a more decided acid character to the triple compound; while a rejection of analogy in this instance, leads others to consider muriatic acid as a binary compound of chlorine with hydrogen. In a case like this, the balance cannot decide, although both the elements be weighable; because the very same chemists who reject analogy in the case of muriatic acid and some similar instances, admit it in the cases of the earths, and have no hesitation to consider them all as oxides, although they imagine some acids are combinations of oxygen, others of hydrogen without oxygen. When unponderable elements are brought into play, there is still more room for disputes, most probably interminable. The phenomena of vision, and of the concentration of light and heat by lenses and mirrors, seem inexplicable, without admitting the existence of substances of far too subtile a nature to be weighed by our balances: and there seems to exist no reason why these subtile elements should not enter into composition with grosser matter. The best, perhaps the only proof of the truth of an hypothesis respecting the elements, would be the discovery of some property in bodies, of such nature that its power in a compound should be in the precise mean between that of the several component parts, according to their respective weights. It is notorious that density or specific gravity, differs considerably in the compound from that of the mean of its constituents, although originally hailed by Archimedes as affording a means of determining the proportion of the constituents in a compound: whether those that study the nature of specific heat, or the phenomena of the refraction and other properties of light may be more successful, must be left to time. The elucidation of the doctrine of the elements, certainly gives the greatest interest to these researches.

Atomic Theory.—When dense bodies are made to unite, some mix in any proportion as water and acids; others only in one certain proportion, called the point of saturation; while others unite in different proportions, the several charges of the variable ingredient forming a very simple ratio, generally 1, $1\frac{1}{2}$, 2, 3, 4, or 5, to the constant ingredient taken as unity. Thus the common carbonate of potasse, commonly called salt of wormwood or salt of tartar, contains 594 of potash united with 275 of carbonic acid; while the supercarbonate or bicarbonate contains 550, that is, twice as much of carbonic acid united with the same quantity of potash. In a few cases, the proportion of one ingredient to the other is very small, as the artificial black lead which crystallizes during the fusion of cast iron, contains only nine parts by weight of iron combined with 90 of carbone, and the native black lead contains only four parts by weight with 96 of carbone.

It has also been found, upon comparing the analysis of a number of substances, into which any two or more bodies enter as ingredients common to all of them, that if a certain number be affixed to any one of them, as A, and corresponding numbers affixed to the others, according to the weight of them combining with the first A, these numbers, say B, C, D, &c. will also denote the proportions in which B, C, D, &c. combine among themselves, to form B C, B D, or C D, or at least some multiple or submultiple of that proportion.

Oxygen, from its great aptitude to combine with other bodies, and from its presence in the most active and common substances employed by chemists, has generally been chosen to form the central point around which the phenomena of chemical combination are arranged, and the smallest proportion in which it combines, is taken by many chemists as the unity of weight in which bodies combine chemically; from whence as a radix or root, the relative weight of the charges of other substances may be calculated, although with some degree of uncertainty, as the number of the charges of one ingredient, that is combined with a single charge of the other, can only be judged of by analogy; although Berzelius, from a consideration of numerous analyses, has collected some general laws which give light on this subject: of which hereafter.

In water, on the common theory, eight parts in weight of oxygen are united with one of hydrogen; hence, if we suppose that water is the protoxide of hydrogen, it is evident, that if the single charge of oxygen be estimated as unity, that of hydrogen will be expressed in decimals by 0·125, or one eighth of the charge of oxygen. But some chemists, of great name, make oxygen combine with only 7·5 of hydrogen to form water; and hence assume 0·132 to denote the charge of hydrogen.

Mode of calculating the Charges.—Upon similar principles, the weight of a single charge of any substance may be calculated, if we have the proportions by weight into which it enters into combination with oxygen, or with any other body, the ratio of whose combining weight to oxygen is already known; due regard being paid to the number of the charges which may be supposed to enter into the combination. Thus it is known, that carbone combines with two different proportions of oxygen, and that carbonic acid gas, which may be esteemed as that which is the most oxidized, contains 72·5 per cent. of oxygen, and 27·5 of carbone. Here, then, we may say, as 72·5, the weight of the oxygen, is to 2, on the supposition of the gas containing 2 charges of that element, so is 27·5, the weight of the carbone, to the weight of a single charge of that element, relative to oxygen as unity; which by the rule of three, will give 0·75 for the weight of a charge of carbone; and, of course, by adding 2 for the two charges of oxygen, 2.75 for that of carbonic acid.

Having thus obtained the relative weight of a single charge of carbonic acid, and knowing that carbonate of lime contains 43·6 carbonic acid with 54·4 lime, the relative weight of a single charge of lime may be found by saying, as the whole carbonic acid 43·6 is to the whole lime 54.4, so is a single charge of carbonic acid 2·75 to that of lime, which will turn out 3·56. Hence, if lime is considered as the union of a single charge of oxygen with calcium, by deducting 1 for the oxygen, the single charge of calcium will be 2·56; but if, with Berzelius, it is esteemed a combination of two charges of oxygen with one of calcium, then the charge of the latter will be only 1·56.

And again, proceeding on this foundation, as sulphate of lime contains 41·6 lime and 58·4 sulphuric acid, the relative weight of a single charge of sulphuric acid is found, by this proportion: as the whole lime 41·6 is to the whole sulphuric acid 58·4, so is the single charge of lime 3·56, to the single charge of sulphuric acid, which will turn out to be 5. As the acid probably contains three charges of oxygen to one of sulphur, then 3 being deducted for them, 2 is left for the weight of a single charge of sulphur.

In like manner, as 100 of fluor spar, which is usually esteemed a fluate of lime, acted upon by sulphuric acid, leaves, after the superfluous acid is driven off by ignition, 175·2 of sulphate of lime; then, as 100 of sulphate of lime contain 41·6 of lime, 175·2 will be found, by the rule of three, to contain 72·88 of lime. This quantity of lime taken from the weight of the fluate, leaves 27·12 for the fluor acid, or fluorine, as some call it. Then, as the whole lime in the fluate, or 72·88, is to a single charge of lime 3·56, so is the whole fluoric acid 27·12 to a single charge of it; which will turn out 1·325; whence, if this acid be conceived composed of a single charge of oxygen, united to one of a combustible basis, the charge of this basis will be 0.325; or, if it be supposed to be composed of a single charge of hydrogen united to one of a substance analogous to chlorine, then, deducting 0·125 for the hydrogen, the charge of the other element will be 1·2.

By proceeding in this manner, throughout the whole circle of chemical substances which have been accurately analysed, the relative weight of a single charge of each element, in comparison of oxygen, or any other radix, may be obtained; when it will be found that the weight of the same charge, as calculated by different modes, will either nearly agree, or be multiples or submultiples of the same number, in consequence of the mistakes which may be made in the number of charges of the elements that have been supposed to unite together to form any compound, and which must of course be rectified as calculation and analogy shall dictate.

This theoretical composition may be expressed by numeral prefixes to the words that denote the elementary constitution. The Greek numerals having been already used to express the series in which the degrees of oxidation take place, those expressive of the absolute number of the charges, may be derived from the Latin language: as, unoxide, unicarbonate, sesquioxide, binoxide, bicarbonate, trinoxide, quadroxide, quintoxide; and on the other hand, subsesquiphosphate, subbisulphate, for salts with excess of base. In this case, oxide, carbonate, &c. might be used for an indeterminate proportion; superoxide, supercarbonate, for an indeterminate charge, known, however, to be greater than the common; and suboxide, subcarbonate, for an indeterminate proportion, known to be less than the common oxide, carbonate, &c.

Chemical Signs.—From a consideration of the simplicity thus introduced into the theory of chemistry, by representing a series of bodies by the number of charges each of them is capable of giving out to another, when made to act upon it, Berzelius has introduced a most excellent and concise mode of expressing the composition of a compound body, by using only the initial letters of the name of its elements, and the usual sign of addition +, with that of the parenthesis ( ), in the same manner as in algebra, to denote a compound which is united to another as a simple. Thus oil of vitriol, being composed of three charges of oxygen, united to one of sulphur and ten of water, which last is itself supposed to be composed of a single charge each of oxygen and hydrogen, the compound is expressed thus: $S + OOO + 10\ (H + O)$; or, more concisely, thus, $S\ O^3 + 10\ (H\ O)$; or, still more concisely, thus, $S^3 + 10\ H^1$: the superior figures in the second case, denoting the number of charges of the element that precedes it, and the third method denoting the number of charges of oxygen; whence, if these superior figures be taken away, the remaining characters express the combustible bases contained in the compound. Sometimes Berzelius denotes the charges of oxygen by dots over the letters expressing the other elements, and the number of charges of these last, by common figures to the left of their sign, or by superior figures to the right: but these dots being inconvenient in printing, inclining strokes, as used by mathematicians for denoting sexagesimal fractions, are preferable. Thus Dr. T. Thomson's late analysis of alum may be expressed by $3\ S''' A'^3 + S''' P' + 25\ H'$. In mineralogical formulæ, Berzelius omits the expression for oxygen entirely, and distinguishes these from the chemical formulæ by using Italic letters instead of Roman.

This mode of curtailing the expression of the composition of bodies is far superior to the arbitrary signs or remote analogies of the Greek clergy. As it is frequently of use to state the proportion by weight of the different ingredients, as well as the charges, Roman numerals might have been used for the one, and Arabic figures for the other: the figures would have been most convenient for the weights, but as the charges are now denoted by them in many works, if both proportions are stated, the weights may be inclosed in brackets.

Speculations on the ultimate Atoms.—Some chemists, instead of confining themselves to the simple enunciation of the facts of this corpuscular theory, have supposed that these numbers represent the relative weight of the ultimate elementary atoms; but on this subject we can know nothing. Our knowledge is bounded by the fact, that the smallest charge of sulphur we can combine with any metal, is twice the weight of the smallest charge of oxygen that can be combined with an equal weight of the metal. This superior weight of the single charge of sulphur may be explained on various suppositions. 1st, The weight of a single ultimate atom of sulphur may be twice that of oxygen ; or, 2dly, the weight of the atoms of all the ponderable elements may be alike, but some may combine singly, others always by twos, others by threes, and so on; or, 3dly, the weight of the atoms may neither be similar, nor in the ratio of their charges, but the ultimate particles of compound bodies may be composed of a numerous assemblage of the elementary atoms, yet so that the ratio of the weight of each element always answers to what is here called the charge.

Equivalents.—Other opinions have been formed respecting these combinations of the elements ; the oldest is that of equivalents. Otto Tachenius, instead of the four elements of the Aristotelians, fire, air, water, and earth, or the three hypostatical elements of Paracelsus, considered all chemical phenomena as dependent upon the reciprocal action of acids and alkalies upon each other, and their neutralization when a proper proportion was added. This hypothesis, or at least the principal feature of it, was brought into a more exact form by Richter, who investigated with great labour the quantities of each acid requisite to saturate the several alkaline substances; and from his researches, Berthollet, I believe, first formed a table of equivalents in two columns, the first column containing the quantity of each of the acids that was necessary to saturate the quantity of each alkali quoted in the second column. But in deducing these quantities the presence of more or less water in the several acids or alkalies confused the result. Lately, the introduction of electricity into chemistry, has enabled Berzelius to improve the Tachenian hypothesis, changing the name of acids into the more general term of electro-negative substances, and that of alkali or base, into that of electro-positive substances, these terms denoting the electric powers of the substance, as it appears by the pole to which the several substances attach themselves when they are placed in an electric or galvanic circle. It is, however, a great objection, that the confines between the two great classes cannot be accurately defined, the same body acting in some combinations as an acid, or electro-negative body, in others as an alkali, or electro-positive body. By combining this theory of equivalent powers of combination with that of the elementary composition of bodies, he has given tables of the relative charges of the several simple bodies, and their oxides or acids; and Dr. Wollaston has laid down numbers denoting the ratio of these charges and equivalents, on one line-of-numbers, with a second sliding line-of-numbers; by which contrivance, on sliding the number, marked on the scale denoting the quantity of any body, even with the place of that body on the fixed line, there is shown, by bare inspection, the quantity of the several elements contained therein, or the quantity of the different acids or alkalies that combine therewith to form any of the salts; or, in the case of its being a simple substance, the quantity of the several compounds into which it enters. This scale of equivalents has its advantages and disadvantages when compared with the use of a common sliding rule, conjointly with a table of elementary charges. Wollaston's scale has the advantage of having the names of the principal substances, of use in the practice of chemistry, upon the face of it; but as they are, of necessity, arranged numerically, they are rather difficult to find; and in respect to other substances, some could scarcely be got on the scale, as its notation extends only to 320, if you begin with 10. On the other hand, the notation of the common sliding rule, when read in a similar manner, extends to 1000, or in the best scales to 1200; and is of universal use in resolving all questions respecting proportional quantities, by the assistance of a table; which latter has this advantage over the names marked on Wollaston's scale, that it may be carried to any extent, and arranged either analogically or alphabetically, so that the numbers denoting the several charges may be found in much less time than when arranged by their numerical value.

Theory of Volumes.—When elastic fluids, or gases, combine together, they unite either in equal bulks, or two or three measures of the one unite with a single measure of the other. In some cases, as in the union of oxygen gas with four times its bulk of azotic gas, to form atmospheric air, this union takes place without any alteration of the bulk; in other cases, as in the union of oxygen gas with only twice its bulk of azotic gas, to form the protoxide of azote of some chemists, originally named nitrous oxide, the mixture forms only two thirds of the original bulk; and in some cases, the condensation is still greater, but always in a very simple ratio to the sum of the bulks before union. Upon this foundation, a supposition has been reared, that if all bodies could be made to assume the form of gas, they would unite in similar proportions, and exhibit similar simplicity in regard to the alteration, if any, of bulk after combination. On this hypothesis, called that of volumes, water is conceived to be a combination of 2 volumes or bulks of hydrogen gas with one of oxygen gas, and hence denoted by 2 H + O; so that, as the specific gravity of hydrogen is only one 15th or 16th of that of oxygen, and is taken as unity, the single charge of oxygen is taken as 15 or 16 by different authors. As few substances can, however, be obtained in the form of gas, recourse is had to calculation; and for this purpose, it is assumed, that if the single charge of any substance, in relation to oxygen as unity, be multiplied by half the specific gravity of oxygen (atmospheric air being unity), or 0·5555, the product will be the specific gravity of that substance in the form of gas; an assumption which is certainly gratuitous, and taken up only for the purpose of extending the theory of volumes, by connecting it with the doctrine of relative charges by weight.

Tria Prima.—There have always existed those who contended for a much smaller number of elementary substances; the ancient philosophers, in particular, were inclined to this opinion, but most of their reasonings refer to the form of a primordial chaos, whether it was liquid like water, rare like air or imponderable bodies, or solid; whether its temperature was greatly superior to the present temperature of the globe, or far inferior, and the like, rather than to the elements of bodies, in the sense in which that expression is now understood It was not until Paracelsus introduced what he called the tria prima, or three hypostatical principles, salt, sulphur, and mercury, that chemists began to form proper opinions on this subject. The mercury of Paracelsus, considered as a general principle, inherent in organic bodies, as well as metals, was explained by Teichmeyer, and others, to comprise spirit of wine and volatile alkali, or ammonia; and several chemists have conceived spirit of salt or muriatic acid, to be intimately related to quick silver. A theory of this kind has been lately revived, and oxygen, hydrogen, and azote, have been supposed to be the only real elements of bodies, from whence the others are compounded. Oxygen thus takes the place of salt, of which it is indeed the active principle on the common theory; hydrogen assumes the office of sulphur in the ancient doctrine, and azote that of mercury: this last may seem an innovation, but it is the predominant ingredient in volatile alkali, or, in the language of publishing chemists, ammonia; and, independent of any reliance upon the analogies and reveries, for they were little more, of the older authors, it must be remembered, that quick silver galvanized in contact with muriate of ammonia, acquires an addition to its bulk and weight, without losing its metallic form, and therefore ammonia is still considered to have some obscure relation to metals.

Libration of human Opinions.—Such is the libration of human opinions. During one age, a theory is in vogue, and is supported by what are, while it is in fashion, considered as irrefragable arguments. As long as it is attacked only in detail on separate points, it keeps its ground; but when a man of industry collects together the scattered strength of the opponents, and produces a system of facts, of superior value to the old system, and explains them upon the new principles, the real value of his work as a repertory of useful information procures it readers among the younger students; some of them follow his theoretical opinions; and thus these gain ground, and by degrees supplant the old, which are, however, cherished by a few, attached to ancient opinions, from a habit of reverence to their ancestors; and some of these, at length, undertake the task of new-modelling the old doctrines, and giving them a polish to suit the real, but very slow progress of science; and thus the old theory again comes on the stage of the world to be again laid aside in its turn, and so on, until the mundane system shall fade away for ever.

Relative Charges of the Elements.—The following table exhibits the ratio of the single charge of the preceding substances, which have been considered as elements, and of their several oxides or acids, in relation to that of hydrogen and oxygen, and the specific gravity, in comparison to water as unity, of such as can be obtained in a solid state; for several, even of the weighable elements, are only to be procured in a liquid or air-like form, and of course their density in the solid state does not admit of an immediate comparison. It is indeed true, that an approximation to the specific gravity of such as enter into an union with other elements, may be obtained by calculations founded upon the principles of hydrostatics. Thus, assuming in a solid combination of two bodies together, the specific gravity of only one, in a solid form, being known, and equal to P, the weight of that body in the compound = W, the specific gravity of the compound = M, the weight of the ingredient whose specific gravity is required = w, then the specific gravity of this body, in a solid form, will be equal to P M w, divided by (W + w) P—W M. But in this case, as the condensation or expansion that always takes place when bodies unite chemically, cannot be exactly appreciated, and varies very much, so every trial will give a different result.

The relative weight of the single charges is given according to the four principal modern authors; by the comparison of them, the student will perceive the discrepancy between them, and the confined knowledge of those who read only a single book, or even the works of one school alone; since he will see, that even in such common substances as the oxides of iron, the black oxide is esteemed by some to contain a single charge of oxygen to one of iron, and by others, to contain two charges of oxygen; and the red oxide is esteemed by some, as containing three charges of oxygen to one of iron, and by others, as three of oxygen with two of iron.

	Thomson.	Brande.	Berzelius.	Wollaston.	Specific gravity.
Hydrogen	1	1·00	6·636	1·32	A gas.
Oxygen	8	7·50	100·000	10·00	A gas.
Water	9	8·50	56·636	11·32	Liquid.
Deutoxide of hydrogen ...	17	- -	- - -	- -	Liquid.
Aluminium	10	16·50	343·000	- -	- -
——— Alumine	18	24·00	643·000	- -	- -
Antimony metal	44	45·00	1613·000	- -	- -
——— Gray oxide	52	52·50	1913·000	- -	6·70
——— White oxide ...	56	- -	2013·000	- -	- -
——— Yellow oxide ..	60	60·00	2213·000	- -	- -
Arsenic metal	38	44·00	839·900	- -	8·30
——— White arsenic ...	54	59·00	1139·900	- -	3·70

	Thomson.	Brande.	Berzelius.	Wollaston.	Specific gravity.
Arsenic. Arsenious acid .	- -	- -	1239·900	- -	- -
——— Arsenic acid	62	66·50	1439·900	- -	- -
Barium	70	65·00	1709·100	- -	- -
——— Baryta	78	72·50	1909·100	97·00	4·00
——— Peroxide.	116	- -	- - -	- -	- -
Bismuth	72	66·50	1774·000	- -	9·80
——— Oxide	80	74·00	1974·000	- -	- -
Boron, Boracicum	6	5·00	73·270	- -	- -
——— Acid.	22	20·00	273·270	- -	- -
Cadmium	56	82·50	- - -	- -	8·63
——— Oxide	64	- -	- - -	- -	- -
Calcium	20	19·00	510·200	25·46	- -
——— Lime	28	26·50	710·200	35·46	2·39
Carbone, Diamond	6	5·70	74·910	7·54	3·50
——— Carbonic oxide . .	14	13·20	174·910	- -	A gas.
——— Carbonic acid . . .	22	20·70	274·910	27·54	A gas.
Cerium	46	86·20	1148·800	- -	- -
——— White oxide	54	101 20	1348·800	- -	- -
——— Reddish oxide . . .	58	108·70	1448·800	- -	- -
Chlorine	36	83·50	See Muriaticum.	44·10	A gas.
——— Protoxide, Euchlorine	44	- -	See Muriaticum.	- -	A gas.
——— Deutoxide, Deep green euchlorine	68	63·50	See Muriaticum.	- -	A gas.
——— Chloric acid	76	71·00	See Muriaticum.	- -	- -
——— Perchloric acid	92	86·00	See Muriaticum.	- -	A gas.
Chrome	28	28·50	708·050	- -	5·90
——— Green oxide	- -	36·00	1008·050	- -	- -
——— Brown oxide	- -	- -	1108·050	- -	- -
——— Chromic acid	52	43·50	1308·050	- -	- -
Cobalt metal	26	43·00	732·610	- -	8·00
——— Blue oxide	34	50·50	932·610	- -	- -
——— Black Oxide	- -	58·00	1032·610	- -	- -
Columbium, Tantalum . . .	144	139·00	- - -	- -	- -
——— Columbic acid	152	146·50	- - -	- -	- -
Copper	64	60·00	806·450	40·00	8·80
——— Orange oxide	72	67·50	906·450	- -	- -
——— Black oxide	80	75·00	1006·450	50·00	- -
Fluorine, Fluoricum	16	15·00	60·000	- -	- -
——— Fluoric acid	F+H	F + H	260·000	- -	A liquid.
Glucinum	18	20·00	683·300	- -	- -
——— Glucine	26	27·50	983·300	- -	2·97
Gold	199	97·00	2483·800	- -	19·30
——— Green oxide	207	- -	2583·800	- -	- -
——— Purple oxide.	- -	- -	2683·800	- -	- -
——— Brown oxide	223	104·50	2783·800	- -	- -
Iodium.					
——— Iodine, Superoxide of Iodium	125	117·75	I + 3O	- -	4·948
——— Iodic acid	165	155·25	I + 2O	- -	- -
——— Superoxiodic acid .	- -	- -	I + 4O	- -	- -
Iridium	48	- -	- - -	- -	18·00
Iron	28	52·00	693.640	34·50	7·78
——— Black oxide	36	67·00	893·640	44·50	- -

	Thomson.	Brande.	Berzelius.	Wollaston.	Specific gravity.
Iron. Red oxide	80	74·50	993·640	49·50	- -
Lead	104	97·00	2597·400	129·50	11·35
—— Yellow oxide	112	104·50	2797·400	139·50	- -
—— Red oxide.........	232	108·25	2897·400	- -	- -
—— Brown oxide	120	112·00	2997·400	- -	- -
Lithium	10	9·00	- - -	- -	- -
—— Lithia	18	16·50	- - -	- -	- -
Magnesium	12	11·00	315·460	- -	- -
—— Magnesia	20	18·50	515·460	24·60	2·30
Manganese metal	28	53·50	711·570	- -	6·85
—— Gray oxide	- -	61·00	811·570	- -	- -
—— Green oxide ...	36	68·50	911·570	- -	- -
—— Brown oxide ..	- -	- -	1011·570	- -	- -
—— Black oxide ...	44	83·50	1111·570	- -	- -
Molybdenum	48	44·00	601·560	- -	7·40
—— Oxide	56	51·50	701·560	- -	- -
—— Molybdous acid...	64	59·00	801·560	- -	- -
—— Molybdic acid ...	72	66·50	901·560	- -	- -
Muriaticum	- -	- -	139·560	- -	- -
—— Dry muriatic acid ..	- -	- -	339·560	34·10	- -
—— Muriatic acid gas ...	C + H		$M^2 + H\frac{1}{2}$	45·42	A gas.
—— Muriatous superoxide, Chlorine	See Chlorine.		439·560	44·10	A gas.
—— Muriatic superoxide, Euchlorine			539·560	- -	A gas.
—— Deep green euchlorine			639·560	- -	A gas.
—— Oxymuriatous acid, Chloric acid ...			739·560	- -	- -
—— Oxymuriatic acid, Perchloric acid .			939·560	- -	A gas.
Nickel	26	28·00	733·800	- -	8·50
—— Gray oxide	34	35·50	938 800	- -	- -
—— Black oxide	76	- -	1033·800	- -	- -
Nitricum	- -	- -	79·540	- -	- -
—— Azote, nitrogen ..	14	13·00	179·540	17·54	A gas.
—— Nitrous oxide	22	20·50	279·540	- -	A gas.
—— Nitric oxide	30	28·00	379·540	- -	A gas.
—— Common air	2 Az. + O		2 N + 3 O	- -	A gas.
—— Hyponitrous acid.	38	- -	- - -	- -	- -
—— Nitrous acid	46	43·00	479·540	- -	A gas.
—— Dry nitric acid ...	54	50·50	679·540	67·54	A gas.
—— Ammonium	- -	- -	6 H + N	- -	A gas.
—— Ammonia	Az. + 3 H		(6 H N) + O	21·50	A gas.
Osmium	- -	- -	- - -	- -	- -
Palladium	56	- -	1418·000	- -	11·00
—— Brown oxide...	64	- -	1618·000	- -	- -
Phosphorus	12	11·00	167 512	17·40	1·77
— Oxide	- -	- -	- - -	- -	- -
— Hypophosphorous acid .	- -	29·50	242·512	- -	- -
— Phosphorous acid	20	18·50	317·512	- -	- -
— Phosphoric acid	28	26·00	367·512	37 40	- -
Platinum	181	- -	1206·700	- -	21·53
—— Black oxide	189	- -	1306·700	- -	- -

	Thomson.	Brande.	Berzelius.	Wollaston.	Specific gravity.
Platinum. Brown oxide .	205	- -	1406·700	- -	- -
Potassium. Kalium	40	37·50	978·000	49·10	0·85
——— Potasse, Kali ..	48	45·00	1178·000	59·10	2·50
——— Peroxide	64	60·00	1578·000	- -	- -
Quick silver	200	190·00	2531·600	125·50	13·50
——— Black oxide .	208	197·50	2631·600	261·00	- -
——— Red oxide ..	216	205·00	2731·600	135·50	- -
Rhodium	120	- -	1490·300	- -	10·60
——— Black oxide	128	- -	1590·300	- -	- -
——— Brown oxide ...	136	- -	1690·300	- -	- -
——— Red oxide	144	- -	1790·300	- -	- -
Selenium	41	- -	- - -	- -	- -
——— Oxide	49	- -	- - -	- -	- -
——— Selenic acid	56	- -	- - -	- -	- -
Silicium	8	15·00	304·350	- -	- -
——— Silica	16	30·00	604·350	- -	- -
Silver	110	102·50	2688·170	135·50	10·50
—— Oxide	118	110.00	2888·170	145·50	- -
Sodium	24	22·00	579·320	29·10	0·90
——— Soda, Natrum ...	32	29·50	779·320	39·10	- -
——— Peroxide	72	- -	879·320	- -	- -
Strontium	44	44·50	1418·140	- -	- -
——— Strontian	52	52·00	1618·140	69·00	- -
Sulphur	16	15·00	201·000	20·00	1·99
—— Hyposulphurous acid	24	- -	- - -	- -	- -
—— Sulphurous acid	32	30·00	401·000	- -	- -
—— Sulphuric acid	40	37·50	501·000	50·00	- -
—— Hyposulphuric acid } 2 S + 5 O	72	- -	- - -	- -	- -
Tellurium	32	36·50	806·480	- -	6·10
——— Oxide	40	44·00	1006·480	- -	- -
Thorinum	- -	- -	- - -	- -	- -
Tin	58	55·00	1470·590	- -	7·30
—— Gray oxide	66	62·50	1670·590	- -	- -
—— Yellow oxide	74	70·00	1770·590	- -	- -
—— Stannic acid	- -	- -	1870·590	- -	- -
Titanium	144	- -	1801·000	- -	- -
——— Protoxide	152	- -	- - -	- -	- -
——— Peroxide	160	- -	- - -	- -	- -
Uranium	125	60·00	3141·400	- -	9·00
——— Protoxide	133	67·50	3341·400	- -	- -
——— Peroxide	274	75·00	3441·400	- -	- -
Wolframium	96	90·00	2424·240	- -	17·50
——— Brown oxide .	112	- -	2824·240	- -	- -
——— Tungstic acid	120	112·50	3024·240	- -	- -
Yttrium	32	30·00	881·660	- -	-
——— Yttria	40	37·50	1081·660	- -	-
Zinc	34	33·00	806·450	41·00	7·00
—— Oxide	42	40·50	1006·450	51·00	- -
Zirconium	37	35·00	- - -	- -	- -
——— Zirconia	45	42·50	- - -	- -	- -

From this table it is easy to calculate the proportion of the elements in 100 parts of a compound body, whose ingredients are known. The value of the charges of each ingredient is to be added together; then, as this total sum is to 100, so is the value of the charges of each separate ingredient, taken one by one, to the proportion existing in 100 parts of the compound.

If the contents of 100 parts of a compound body be given to find the relative charges of each ingredient, then the proportion of each ingredient being divided by the value of a single charge of it, will give the charges of them existing in the compound; but these values will almost always be fractional, and must be reduced to integral expressions by repeated trials.

Crystalline Forms.—Although the objects of chemistry are, properly speaking, unorganized bodies, yet many of them, when separated slowly from a solvent, assume a regular figure, and are then said to be crystallized. Even when in shapeless masses, many have a regular texture. Much attention has been lately paid to this quality by Romé de Lisle, Hauy, and Brewster, as also Mohs, who, pursuing the traces of Woodward, has endeavoured to establish a system of minerals upon this foundation, conjoined with that of the hardness and specific gravity. He establishes four systems of crystals: the rhombohedral, or that which is derived from a rhombohedron; the pyramidical, or that which is derived from an isosceles four-sided pyramid; the prismatic, or that which is derived from a scalene four-sided pyramid; and the tessular, or that which is derived from a hexadron. A circumstance, however, has been found to occur, that prevents the chemist from placing any confidence in the form of the crystal, or consequently in the texture of the mass, namely, that several substances may supply one another's places in crystals, without occasioning any change of form; hence, these substances are denominated by the discoverer of this curious but perplexing fact, isomorphous bodies. Such are phosphoric and arsenic acids, in the phosphates or arsenicates; also the protoxides of iron, of zinc, of cobalt, of nickel, and of manganese, and the deutoxide of copper, with lime and magnesia in many minerals. A third series is presented by alumine, and the deutoxides of iron and manganese; a fourth by barytes, strontian, and the oxide of lead; a fifth, by chlorine and iodine; and a sixth, by sulphur and selenium. Thus, in the stones called amphiboles, which in their purest state are composed of one particle of the trisiliciate of lime, combined with three particles of the bisiliciate of magnesia; not only the two bases, lime and magnesia, may be substituted for one another, but their place may also be supplied by other isomorphous bases, particularly by the protoxides of iron and of manganese. Some amphiboles contain also fluate of lime; and it also appears, that the bisiliciate may have its place supplied in this combination, by a trialuminate either of the same or of an isomorphous base. This substitution of one base or acid for another, offers considerable difficulty in attempting to arrange minerals by their chemical composition alone.

Many English chemists, mineralists, and crystallographers, call these substitutions by a gross Gallicism, replacing one substance by another; and in like manner, they speak of one angle being replaced by a plane or the like; not considering, that replacing, signifies in English, a return to the state from which the subject had been, at some time past, displaced.

Atmospheric Air.—In descending to particular chemistry, the atmosphere again first claims attention. It is always in the form of an elastic fluid or gas, however low the temperature, or however it may be compressed. At the ordinary temperature and pressure, a gallon weighs about 71 grains; its specific gravity, at 60 deg. and 30 inches, being 0·00122, according to Biot and Arago, so that of water is 820 times as heavy as air. Its principal component part is considered as a mixture, or more properly, a chemical union of 4 measures or 2 charges, of azote with one of oxygen, whatever may be supposed to be the nature of the former ingredient. If Berzelius's theory of nitricum be adopted, it will, of course, be $2\,N + 3\,O$, or $N^{1\cdot5}$. This compound constitutes, on an average, 989 thousandths of the weight of the atmosphere, to which are added, 10 parts of watery vapours, and one of carbonic acid gas. Several other substances are accidentally mixed with the atmosphere, but the above two are found in all places. Some of the impregnations of the atmosphere can only be discovered by their effects upon the human body, in producing certain kinds of diseases, in which the most astonishing circumstance is the locality of the impregnation, in consequence of the slow diffusion of the empoisoned atmosphere, that infects first one quarter of a town, and then gradually but slowly extends itself, particularly in the poorer quarters; the greater number and power of the fires used in cooking in the richer quarters, seeming to prevent the accumulation of the poison. The neighbourhood of stagnant water is particularly liable to become infected; but large elevated tracts in Italy are infested with malaria, or empoisoned air, probably from subterraneous vapours. The slight barriers that prevent this accumulation, as a wall, or a tall hedge, have been shown in monastic communities, commercial companies, or large households, who have thus escaped in the most cruel plagues, and in places most exposed to infected air, as in the Pontine marshes near Rome. It is well known, that travellers may pass through places infected with the plague without infection, provided they do not tarry in them; and also, that those who live on open heaths, in camps, like the Bedouin Arabs or gipsies, wear with impunity clothes newly taken from those dead of the plague; both which circumstances seem to show, that a certain quantity of the poison is necessary. So again, it is certain, that persons going from infected places to others, on foot or horseback, although at a moderate distance, do not communicate the diseases thus generated: a fact well known when the plague was rife in London, and the King's court, the public offices, and the courts of justice, were held at Oxford. For the sake, however, of patronage, or jobs, governments often form quarantine establishments that are dreadful vexations to travellers and importers of foreign goods; the ministers being urged thereto by medical men, who either thirst after superintendencies for themselves and their dependents, or are bribed by the commercial agents of another more knowing nation, who being free from these vexatious interruptions, are thus enabled to forestall the market, to the great injury of the native merchants, as is the case of the Dutch, in respect to Levant goods in England. A still more cruel expedient has been resorted to by Europeans, that of shutting up the inhabitants of an infected air until it becomes so diluted by diffusion as no longer to produce the diseases; thus sacrificing a large part of the population to the fear of communication by transport. Far more humane would it be to set fire to the town, and drive the inhabitants out, with their most valuable baggage, several times through a river or large body of water, making them encamp in a loose scattered order, or even lie unsheltered for some time on an open blowing situation: by which the air adherent to them would be got rid of, and the source of the empoisoning of the air would be destroyed; or, if it depended upon subterranean vapours, be stopped up by the rubbish, as we see has happened in London, where, since the great fire, plague or ague is scarcely known, although common before. In incipient cases, instead of shutting up the inmates of a house, they might be bathed, and then marched out to an open blowing situation, and the house fired. The immobility of such a rare fluid as air, except by fire or suction, is astonishing. In the preface to Baader's Treatise on Blowing Machines, it is observed, that Wilkinson laid down a pipe 5000 feet long and one foot diameter, between a blast furnace and its blowing machine, in order to have the benefit of a good fall of water for the latter; but on endeavouring to force the air through the pipe, the attempt was vain: not the slightest wavering was produced upon the flame of a candle, and the blowing machine stopped in a very short time. To ascertain whether any accidental stoppage had occurred, a cat was put in at one end of the pipe, which soon walked out at the other. On drilling holes, it was found, that at 600 feet from the machine, only the faintest breath of air could be obtained.

The obstinate adhesion of air to solids, is well shown and very troublesome in hydrostatic experiments. When a solid is attempted to be weighed in water, air is carried down and gradually collects on its surface in bubbles, which must be removed by knocking against the sides of the vessel, or a camel's hair brush; and this must be repeatedly performed, before the whole is got rid of.

Animals confined in a small portion of air, change it into a mixture of azote and carbonic acid gas, without altering its volume. Whether this alteration is produced by the absorption of oxygen by the lungs, and emission of carbonic acid gas, or whether the oxygenous portion combines with carbone thrown off by the lungs, is disputed. Most animals die long before the change is complete, but slugs live as long as any air remains unaltered. Plants also change the oxygen of the air into carbonic acid gas, during their growth in the night, but in the daytime they again change this acid gas into oxygen, and thus restore the atmospheric air to its original state.

Water.—The purest natural water is rain water, and then that of a clear river; either may be used for general purposes in chemistry, reserving distilled water for very accurate experiments only. The dispute respecting the simplicity or compound nature of water, has been already mentioned. It is the universal diluent or drink of organic bodies, whether animal or vegetable, and plays an equally active part in the production of minerals, by dissolving, or merely holding them in a state of suspension, so that they may unite according to the laws of the omnipotent Creator; or, by serving as the liquid agent in those immense galvanic piles formed by the strata of the globe, and thus producing the phenomena of volcanoes, and their various ejections. Water is also used in the far greater part of the operations of chemistry; the dry way, as it is called, being seldom resorted to when it can be avoided. Being always at hand, it is assumed as the unit of comparison for the specific gravity of bodies. It is singular, that its contraction by cold ceases at 40 deg. F. after which it expands to the freezing point; when at rest, it may be cooled down far below that point without becoming ice, but on the slightest touch or breath of air, it instantly freezes. For long voyages, it is best kept in casks that have had their staves charred on the inside, or fresh made charcoal may be mixed with it; if thick, it may be cleared by filtration, which is best performed by ascent: into a wide vessel of middling height a layer of sand is put, on the middle of this, a tall vessel with a hole in its bottom is placed, half filled with coarse sand; the space between this and the sides of the shallower vessel, is partly filled with a layer of very fine sand; water being then poured into the central tall vessel, filtrates through the sand, and is thus rendered clear, when it may be drawn off by a crane.

Besides the medical use of water as drink, it appears also necessary that water, in a state of vapour, should be mixed with the air to fit it for healthy respiration or vegetation. And the Italians of the Alps place shallow dishes of water on their stoves, to prevent the headache, to which persons who live in stove-heated apartments are subject.

Charcoal.—This is usually manufactured from coppice wood, cut every 16 years; the faggots are made into a large conical pile, covered up with clods of earth, leaving circular rows of holes from top to bottom. The wood is then kindled, and as it becomes red, the holes are regularly closed to stop the further combustion, and when the whole has been closed up, the pile is left to cool; when the black skeleton of the wood is left, which differs from the raw wood in burning without any smoke, and with little or no flame, yielding at the same time no soot, although some of the finer particles of the ashes are volatilized and adhere to the chimney. The air which passes through the burning charcoal has its oxygenous part converted into carbonic acid gas, without being, when cooled, any ways altered in bulk, although its weight by the gallon is increased. The air being thus rendered unfit for respiration, kills whatever animals or plants are confined in it: numerous accidents have happened of persons being suffocated, by sleeping in close rooms with a charcoal fire.

The charcoal for medical purposes should, like that for gunpowder, be made of soft woods, as alder, heated in iron long necks until no volatile matter is given out. Small quantities may be made, by burying wood under sand in a covered crucible, and exposing the whole to fire. It conducts electricity like the metals, and when newly made, and with a heat not exceeding a dull red, it destroys the smell of putrid meat, or putrid water; it is also the best tooth powder when the teeth are carious, and is mixed with poultices for foul ulcers. Internally, it is given to ʒj, as an antiseptic tonic, instead of Peruvian bark; and is also mentioned as an excellent medicine in obstinate constipation.

Charcoal is supposed to be carbone, combined with an exceedingly small proportion of hydrogen, and of different earths: that highly valued gem the diamond, differs from charcoal only in not containing any hydrogen.

A kind of charcoal is prepared for medical use from sponge, and improperly called spongia usta; it contains iodine and other substances, the first of which renders it available in bronchocele.

Lead and Litharge.—Lead is obtained from an ore very similar in its appearance to lead itself, called potter's lead ore. This is heated, either by being placed in layers with burning fewel, or in a reverberatory furnace to volatilize the sulphur with which the lead is combined in the ore; the roasted ore is then smelted, either in a reverberatory or blast furnace. As most lead ores contain a sufficient portion of silver to pay for its separation, this lead is melted on a shallow bed of bone ashes, or wood ashes well washed from their salt, and the glass that is formed on its surface, is allowed to run out of the furnace, leaving the silver behind; when cooled, this glass acquires a peculiar scaly appearance, and is called litharge, which is supposed to contain 7·73 of oxygen, combined with 100 of lead. As more litharge is produced than is required in the market, the greater part is reduced to lead again, by being melted in contact with the fewel.

Lead is the heaviest of the cheap metals, being 11·35 times as heavy as water; when rolled out in sheets, it is used as a compressing power to tumours and ulcers, and to flatten the bosoms of women, who prefer fashion to either health or the dictates of nature. It dirties the hands, and by frequent handling produces palsy.

Red Lead.—Red lead is formed by heating litharge in contact with air, for about 48 hours. Its specific gravity is 8·94, and it appears to contain 11·08 of oxygen to 100 of lead; whence the specific gravity of solid oxygen, supposing no condensation, is by calculation, 3·06. On being melted, this oxide = 2 L + 3 O, parts with a portion of oxygen, and returns to the state of litharge, or L + O.

White Lead.—White lead is prepared by exposing blue, that is to say, common lead, to the steam of vinegar, by which it is corroded and changed into a white flaky substance, called in trade, flake white. When reduced to powder it is denominated ceruss or white lead. It is not soluble in water, and is composed of 83·5 per cent. of yellow oxide of lead, and 16·5 of carbonic acid. Taken inwardly, by carelessness or design, it occasions palsy; externally, it is astringent and sarcotic.

Copper.—Copper is mostly obtained, by metallurgists, from its native sulphuret, which resembles brass, but is usually tarnished. The sulphur is got rid of by roasting, as in the lead ore, and the remainder is melted in reverberatory furnaces for copper. Copper is about 8·7 times as heavy as water; when melted, a bluish flame hovers over it. This metal is not poisonous, as is commonly supposed, but is prescribed for the rheumatism, in doses of a dram: numerous cases of copper coins swallowed by children, without causing any injury, other than what arose from their hardness and size, are on record; they have uniformly been rejected in time by stool.

Iron.—The most common of all metals and the most useful is iron; or, as it is pronounced by us, and written by the Swedes, from whom we probably received the name with the metal itself, iern. It is usually obtained from its native oxides, which are smelted in blast furnaces, of considerable height: the cast iron, thus obtained, is purified by being kept in fusion until it becomes solid or unfusible, when it is either hammered or passed through rollers to squeeze out the heterogeneous matters. Small nails, or wire, is usually employed in chemical operations; sometimes, iron turnings, or filings cleansed by having a loadstone passed over them, those only being taken which adhere to the loadstone. The usefulness of iron in the mechanic arts, is augmented by its property of joining together when two pieces are heated to a red heat and hammered, in the same manner as dough or pill masses The filings are given as a tonic up to ʒſs in a day. The scales or protoxide, that fly from it, when white hot and hammered, are also ground and used like the filings. Iron, heated with charcoal powder for some hours, acquires the property of becoming very hard when suddenly cooled, and of being softened by being heated and gradually cooled. This carburet of iron is called steel, and was formerly preferred in medicine. Iron filings in water are very slowly reduced to a protoxide, and hydrogen gas is emitted; this is usually ascribed to the decomposition of the water. Hydrogen gas may be obtained quicker by making iron turnings, or wire, red hot in a stoneware tube, placed across a fire, and passing the steam of water through the tube; the hydrogen gas is driven out at the end, and its weight added to that, by which the protoxide of iron exceeds the original weight of the iron is equal to that of the water that disappears: hence it is assumed, by most, that the water is decomposed into oxygen and hydrogen; while others explain it differently. The hydrogen gas, which is disengaged when iron acts upon water, renders the oxide preferable as a medicine, as not occasioning flatulence.

Tin. Tin is almost peculiar to this country, and is obtained from its native oxide, by fusion through the coals.

Its specific gravity is 7·29, being scarcely heavier than the oxide. Tin is brittle at the moment of fusion, and may then be reduced to powder by being shaken in a wooden box, rubbed on the inside with chalk; it is reduced by rolling into leaves, called foil, which are about 0·001 in. thick. To reduce it in price, lead is mixed with it when used for vessels; this alloy is called pewter in England, but simply etain in France, where tin itself is denominated etain d'Angleterre. Pewter has been supposed unhealthy for culinary or pharmaceutic use; but Proust, having been commissioned by the Spanish government to examine this matter, on account of the lemonade sellers of Madrid using pewter vessels, found that none of the lead is taken up by acids left in them; the dark-coloured precipitate, produced from the lemonade by hydrosulphuret of potash, which had misled former chemists, being merely a sulphuret of tin, without an atom of lead. Tin filings are given against worms in children; their action is ascribed, by some, to mere irritation of the worms, dislodging them from the intestines, and causing them to be swept away with the feces; and by others, to the disengagement of hydrogen gas, arising from the metal decomposing some of the liquid contents of the intestines; this gas poisoning the worms. When melted in the open air, it slowly calcines into a white oxide; 2 oz. French, absorbing 20 gr. of oxygen from the air. Pewter heated to a certain degree, throws out the tin in the state of an oxide, all at once.

Quick Silver.—The most fusible metal, so much so, indeed, as to be usually found in its melted state, in the atmospheric temperature, is quick silver, still called by most writers and medical men mercury; but why this single metal should retain the name given it by mathematicians, when the others are no longer called by their astrological analogies, does not appear; indeed it were better to leave such idle fancies to barometer and thermometer makers, or to the proprietors of quack medicines. Quick silver, at the ordinary temperature, is about 13·5 times as heavy as water; it freezes at 39 deg. below the zero of Fahrenheit's scale, and is then malleable. When kept nearly boiling for some time, in a flat bottom glass, with a very long narrow neck, open at top to admit the air and yet prevent loss by evaporation, it absorbs oxygen from the air, and is converted into a red crystallized oxide, called precipitate per se, or calcined quick silver. If this oxide be heated strongly, it lets go the oxygen that was absorbed, and the quick silver, being volatile, passes over also: this was the original process to obtain oxygen gas, but cheaper methods have been since invented. Quick silver unites easily with lead and tin, not so easily with copper, but iron merely swims on it, and after a long time becomes rather brittle. Quick silver increases the flow of saliva, loosens the teeth, induces trembling of the limbs and palsy, but has a specific action on the venereal lues; for this purpose, the red oxide is given in doses of half a gr. to gr. ij in a pill; in larger doses, as gr. iv, it is a violent emetic; externally, it is used to consume luxuriant granulations. The crude metal is given in very large doses, even to a lb. or more, in obstinate costiveness; a practice which sometimes answers the purpose.

Lapis Calaminaris.—The lapis calaminaris is an ore of zinc, of various composition; one species being a siliciate of zinc, the other a carbonate of zinc. The first kind, on being heated, exhibits strong signs of electricity, and loses only 12 parts in 100, by heating to redness: the latter loses about 34 per cent.: both also contain in general, oxide of cadmium. They are roasted, and used for making brass and zinc, and also, externally, in medicine, as dryers: the carbonate, being a pure oxide after it has been roasted, seems preferable.

Zinc, or Spelter.—Zinc, being volatile, is procured from lapis calaminaris, by adding charcoal dust to the roasted ore, and distilling it with a very violent heat. The cadmium, being the most volatile, comes over first, and is suffered to burn in waste, which it does with a brown blaze, covering the walls with a whitish sublimate, called spodium, containing nearly one third of oxide of cadmium. When the blue blaze of zinc appears an adopter is affixed, and the oxidation being prevented, the zinc is distilled into water. This metal is blueish white, about 7 times as heavy as water, clogs the file, and when exposed to the fire, burns with a very brilliant flame, and yields a white oxide, that hangs about the crucible in the form of white flocks, called the flowers of zinc, which are considered as antispasmodic, in doses of gr. j to vj, twice a day; they are also used externally in ointment for the eyes, as being a finer powder than lapis calaminaris, however well ground.

Spodium may be distilled with charcoal for the cadmium, which is a white, hard, and ductile metal, 8·75 times as heavy as water.

Bismuth.—Bismuth has some resemblance to zinc, but is of a yellowish cast, very brittle under the hammer; it is found native in mines, and requires only fusion with a gentle heat to run it from the stony matters with which it is intermixed. In a strong heat it burns with a small blue flame, and a yellowish oxide is sublimed; this oxide melts into a greenish glass.

Antimony.—Sulphuret of antimony, or antimony, as it is called in trade, from the name given it by the Latin translator of Avicenna, is also found native, and requires only to be separated from the stony intermixture by fusion. In this sulphuret, each 100 of the pure metal is combined with about 35 or 36 of sulphur. Sulphuret of antimony is used as a diaphoretic alterative, in cutaneous diseases, to ʒij in a day; and is largely used by ferriers and grooms to cause horses to have a smooth and fine coat. When powdered and exposed to a slight heat, in a shallow dish, until it no longer emits a smell of sulphur, it forms a gray mixture of about 85 parts of protoxide and 15 of the sulphuret, called calx of antimony, which melts by a greater heat into a transparent yellowish glass of antimony; if more of the sulphuret is left in the mixture, it melts at a less heat, into an opaque brown mass, called liver of antimony; on the other hand, if the roasting is continued long, the oxide is purer but is difficult to melt, unless a little antimony is flung into the crucible, to restore the sulphur and increase the proportion of the regulus to the oxygen. These preparations are much used by ferriers, as active alteratives in farcy, and other obstinate cutaneous diseases of horses: they are too violent and uncertain in their action on the human body. If the well roasted oxide is mixed with charcoal dust and heated, the oxide is reduced by the carbone of the charcoal uniting with the oxygen of the oxide, and forming carbonic acid gas, which flies off and leaves the metallic part of antimony free; which, as has been said, most publishing chemists call antimony, regardless of the discrepancy thus needlessly produced between the common and philosophical language; but which Berzelius calls stibium, from the name used by Pliny for antimony. This metal is volatile in a red heat, and flies off in the form of a white fume, which settles on any cold body, and is then known as silvery flowers of antimony.

Gold.—Gold is found nearly pure, in small grains, in the sands of rivers, even in the British Isles. It is 19·3 times as heavy as water; remarkably ductile, as a single grain may be beat out so as to cover nearly 40 square inches; too soft for general use, unless hardened by the addition of an alloy, which when composed of equal parts of silver and copper, and used in the proportion of 1 alloy to 11 gold, does not much impair the ductility. Gold melts not, until after it is red hot; it either does not absorb oxygen from the air, or if it does, as has been supposed from the blueish green colour emitted, the oxide is immediately decomposed. When pure, neither air nor water tarnishes it. Gold melted with lead is not oxidized with it, but is left on the vessel after the litharge has soaked into its substance. It is used by the apothecaries to gild their pills, and being formerly esteemed highly cordial, it was left to float in draughts, mixtures, and tinctures, having that intention.

Alchemy.—Gold has the greatest commercial value of all the metals in common use, being about 14 times as valuable as silver, and nearly 8000 times as valuable as lead. Now, as there is so much resemblance between the various metallic bodies, and they form a class so distinct from others, it was natural for the earlier chemists to imagine, that they were composed of a small number of elements variously combined, and of course, probably transmutable one into another. Although this opinion is not yet proved, yet the great difference of their commercial value, has always enticed the chemists to risk considerable labour and expense in attempting to discover a mode of transmuting the cheaper metals into those that are far dearer. Even when this pursuit does not injure the fortune of the individual, it is still very injurious to science, in that it has a tendency to induce a commercial mysteriousness on the subject, and to prevent him from communicating his unsuccessful experiments to the world, lest they should furnish hints to others who might forestall him in the pursuit; this mysterious concealment of the object he has in view, and the progress he has made in it, being also, in some measure, forced upon him, by the severity with which poets, and other self-constituted legislators, have lashed those who attend to the subject. It is true, that fraudulent swindlers have often chosen this mode of attacking avaricious persons on their weak side, and used a pretence of knowing the art of making gold or silver from cheaper metals, to levy contributions on their purse; but every description of human knowledge is liable to abuse by a few.

Alchemy of the Greek Clergy.—The oldest books known on the subject, which seems to have first occupied the attention of writers at the time when the Christians began to form a political society, and to attempt the attainment of the possession of the Roman empire, are those of the bishops and principal monks of the Greek church; Synesius, Aristotle the monk, Nicephorus, and others. None of the ancient historians, poets, or even satirists, mention the transmutation of metals; and Julius Maternus Firmicus, who wrote at the beginning of the fourth century, is the most ancient author that has noticed it. From the work of Aristotle, an idea may be formed of the theory of these speculators. Series were formed of the metals in respect to their qualities; as their colour, specific gravity, oxidability, facility of solution in acids, and the like; to which numbers were affixed denoting the intensity of the several qualities. From whence they proceeded, according to the arithmetical rule of alligation alternate, to compound them; so that a metal might be formed, which, if not really one of the precious metals, would be undistinguishable from the real. The great specific gravity of gold, exceeding that of any other metal, and which, of course, could not on this theory be formed from any mixture of lighter substances, seems to have turned their attention more to the making of silver, or a metallic alloy resembling it. This theory was evidently assumed without examination; for, had these reverend chemists proceeded synthetically, to combine the metals two and two together, they would quickly have found, that the properties of alloys are not deducible by calculation from those of their component parts. It may, moreover, be inferred, that they considered even the common metals to be compounds, as this monk proposes very operose defecations of them. The invention of an apparatus for distillation, apparently by Zosimus, of Panapolis in Egypt, about the year 600, and the discovery of the acid of nitre, in which the metallurgists saw with surprise, the hardest and most perfect metals melt like ice in hot water, seem to have given a great impulse to observation, and to have produced a very general attention to chemical pursuits, and particularly to the solution of those problems which offered the most tempting advantages, whilst the freshness of the subject prevented its difficulties from being duly appreciated. This salt seems to have been concealed by the Christian Greek clergy, under the name of the philosopher's stone, on account of the resemblance of its crystals to those of rock crystal; a resemblance so striking, that Linnæus, ascribing the figure of crystallized stones to an impregnation of salt, arranged rock crystal in his genus nitrum, along with salt petre. It appears from the Summa Perfectionis of Geber, that several theories had been devised in the interval between Zosimus and his own time, supposed to be about the year 800.

Geber.—It is to this author that we are indebted for the first books on the nature of metallic substances, that can be denominated scientific; those of Aristotle the monk being a mere collection of receipts, without any clue to show the student the reason of a single step. Geber, on the other hand, being accustomed to the regular and progressive mode of demonstration used in the mathematics, in which he was eminently versed, as appears by his capital invention of what is called the trigonometric canon, proceeded on experimental grounds, and exhibits his reasons, which, however, are dreadfully mangled in the wretched translations of his works, by persons imperfectly acquainted with metallurgy. Enough, however, remains, to show the excellence of the original, to those who will take the trouble to reduce the translation, as it now appears, into smoother language.

He considers the common metals as compounds of sulphur, arsenic, and quick silver. These volatile substances were fixed upon, because he conceived that metals were formed in a gaseous state, by means of heat in the mines, and then condensed in the veins and strata of the earth: and volatile substances alone can be made to enter metals without occasioning the loss of their metalleity, as the above, along with tutty, that is to say, zinc, and two others, namely, marcasita, now called sulphuret of antimony, and magnesia. From this union of metals (bodies) with volatile minerals (spirits), arise two imitations of the perfect metals, brass, or imperfect gold, from copper, citrinated by tutty; and Britannia metal, or imperfect silver, from the same metal, whitened by arsenic. The energies of his mind were therefore expended in devising methods to fix these volatile minerals, or in endeavouring to cause a more intimate union of the metals and volatile minerals, by imitating the slow operations of nature, and substituting these for the hasty fusions and rapid coolings of the common metallurgists. With this view, he gives various modes of practice, such as repeated sublimations; in which operation, as is well known, sal ammoniac, by degrees, refuses to rise without a considerable degree of heat, and remains melted at the bottom of the vessel; also the solution of two or more metals, or their oxides, in acids, separately, then joining and digesting the mixed solution for some time, precipitating the metals, and reducing, or, as he terms it, incerating, the precipitate with oils and subsequent fusion. Conceiving that coarse oils may introduce feculent matter into the regulus, or alloy, thus produced, he employed the distilled and rectified oil of soap, the oils of eggs, of human hair or of gall repeatedly cohobated upon sal ammoniac, or upon crystallized verdigris. Sometimes he cohobates distilled vinegar repeatedly on the precipitate, until it has imbibed a considerable portion, and then proceeds to fusion. At other times, he alloys two metals, calcines the alloy, reduces the oxide by inceration, and repeats these operations several successive times. To prevent as much as possible the absorption of unmetallic matter from the supernatant slag in reductions, by means of saline and earthy additaments, he placed several layers of cylindrical rods near the top of a conical crucible, on which the powder to be fused was laid. On the revival of the metal by the heat, it descends, as he expresses it, through the pastills, which prevent the falling down of the thick slag. At other times, he dissolves the metals to be united, in quick silver; digests the amalgam for a long time, and at length separates the quick silver. Though these methods may fall short of producing perfeet gold and silver, yet they are certainly good processes for obtaining the most perfect metallic alloys. With a view still further of excluding extraneous matters from entering at the close into the regulus, he advises the extraction and concentration of the changing matter or medicine, as he terms it, such as the separation of the sublimate (zinc) from tutty, instead of employing crude materials. These medicines, elixirs, or stones of the philosophers, he divides into three orders for each of the two metals, silver and gold, which are to be imitated. The first order comprising those that give the proper colour, but the medicine being volatile it flies off in a long continued heat, as tutty and arsenic, in respect to copper. The second order, colour the metals but diminish some of their metalline qualities, either by rendering them brittle, or diminishing their fusibility. The third order are the most perfect, as they give a good colour without the diminution of their metallic qualities, or even with an improvement of the metal; as the regulus of antimony renders tin harder and more silver-like, and yet the alloy will bear the screw press. This classification is a sufficient proof that neither alchemy, nor the philosopher's stone, in the sense now attached to those terms, were the object of Geber's study.

Introduction of Alchemy into the West.—The rapid conquests of the Arabs threatening Europe, the crusades were engaged in; by some, from motives of religion, by others, from principles of sound policy, to make the enemies' country the seat of war. In the course of this warfare, the works of Geber fell into the hands of the Europeans, and were abridged, but without any acknowledgment, by Albert von Bolstadt, Bishop of Ratisbon, commonly known in the divinity schools, by the title of Albertus Magnus. This abridger, or rather plagiarist, seems to have been incapable of perceiving the scientific form in which Geber had cast his subject, and deceived, probably, by the riches of Asia, into an opinion of an art of making gold and silver being actually practised, has reduced his work into a mere mass of prescriptions for making the precious metals. Although the crusades were the means of introducing the study of experimental metallurgic chemistry into Europe, they were also the cause which retarded the progress of that knowledge. During this absence of most of the landed interest of Europe, in Palestine and Egypt, the necessary remittance of their revenues passing through the hands of the Roman clergy, it brought the latter to a knowledge of the banking trade, induced on them a commercial character, and, as usual with bankers, was attended with a flow of riches which increased their power, and enabled them to dispute pre-eminence with the several civil governments under which they lived. The strenuous resistance always offered by churchmen to innovation, although it may be a manifest improvement, and in most instances, very justly, lest by losing a single peg the whole frame of society should fall down, leading them to keep up some old church establishments long after the temporal powers, with which they were once connected, have been overturned, without hope of restoration, and new church establishments formed, as we see in the Jewish and several Christian establishments: so the Roman clergy, still retaining their political attachment to the Pontifex maximus of the western empire, although that empire had been for some time broken up and divided among several temporal princes, this union under a single chief gave them a political power, which being aided by the small means of coercion that the temporal princes had over their turbulent subjects, rendered the Roman clergy and their adherents, the military monastic orders, at one time paramount in Europe. This banking trade, carried on by the clergy, was the principal cause of the retardation of chemical knowledge, by its professors being marked out as objects of persecution. The Europeans were at that time not far removed from barbarism, and therefore the magnificence and high civilization of the Oriental nations excited their admiration, and produced a desire of imitation, which was kindled in its progress in consequence of the custom of paying rents in personal services, rather than by any medium of commerce. The introduction of money rents in lieu of personal services, was the first step to civilization; but the revenues obtained, not being sufficient to answer the increased demands of the luxury now introduced, and the princes not being able, from the precarious situation in which they stood, to levy any occasional deficiencies upon their subjects by direct taxes, were driven to the only remedy they had, that of raising the nominal value of the coin above the intrinsic value of the metal, and thus to make a large profit upon their mint. This method was, however, open to numerous frauds, the more especially, as the coinage was easily imitated, being very coarse in its workmanship, and produced a numerous tribe of false coiners, whom the civil powers had thus peculiar reasons for viewing with a malign eye. The banking trade in which the clergy had engaged, led the way to their being deeply implicated in this false coinage, especially the Knights Templars, who were at that time in Europe what the East India company is at this time in Hindoostan, and engrossed nearly the whole of the commerce. They endeavoured, however, to charge the crime upon others, and particularly upon the Jews, who were their rivals in the banking line, were strongly connected with the civil government, and especially protected by it, to which indeed they were indebted even for their existence,* and to which they stood somewhat in the nature of libertini, or freed men, and might be shorn of their property at pleasure. In these circumstances, and amidst this collision of interests, chemistry making its appearance as the art of making gold and silver, excited much attention. By some it was greedily embraced as the readiest road to riches, and they engaged in the pursuit with ardour. To persons implicated in the false coinage, it served as a pretext to cover their frauds, on account of the apparatus being similar. The revenue officers looked upon it with a suspicious eye, not only for that reason, but also because, according to the law, all gold or silver that was extracted from mines or minerals, was the property of the sovereign, at a low fixed rate. The civil power, therefore, taking an alarm, exerted all its force against the false coiners, or whoever bore any resemblance to them; nor could the superior orders of the church refuse to give their assistance on the occasion. Chemistry being thus persecuted, could not be expected to flourish, for science is a tender plant, and does not, like any religious sect, which is a simplification of pre-existing establishments, grow up the faster the more it is attempted to be repressed. A few individuals, who had powerful protectors, as Roger Bacon, or those whose character placed them above suspicion, as Albertus Magnus, were the only persons who could openly study it; but the unfortunate direction it had taken to a single point, necessarily retarded its progress. And those, who thus publicly avowed their attach ment to it, were commonly obliged to write of it in a manner much beyond their knowledge, to support the reputation they had gained in other sciences; by which means, a quantity of trash was given to the world, under the veil of great names: at the same time, a number of literary forgeries was produced, and greedily purchased by the credulous and uninformed. As the slightest experience showed the falsity of these processes, the art itself was brought into contempt. The chemists being regarded with jealousy, both by the civil and ecclesiastical powers; stigmatized by the former as defrauders of the revenue, by adulterating the coin; by the latter, who could not avow their real motive, as magicians and atheists; and further regarded by the intelligent classes as swindlers; it is no wonder that so few chemical authors of any reputation are to be found in this period.

Original Theory of Transmutation.—From the writings of the times, however, it may be inferred, that the scientific form into which Geber had endeavoured to reduce chemistry, and his moderate views, were early abandoned, and a new theory of the perfecting and ripening the common metals into gold and silver was promulgated, of which the following is an outline. The generation of metals and minerals is analogous to that of vegetables and animals, and they are not produced instantaneously. Hence the alloying of metals by fusion does not change their nature, it being necessary that they should be in a situation to act upon each other for a considerable time before any radical change can take place. Continued fusion will not answer this end; a mild and temperate heat being necessary in all natural generations, and also on account of the oxidation which takes place in that operation, if the air be not carefully excluded; therefore, the two metals must be dissolved in a solvent, the solutions mixed, and in this state long digested, that they may re-act upon each other, and produce a new compound. In dissolving, however, metals in acids, which solvents are alone capable of dissolving them, they are oxidized and lose their metallic form. Being thus altered, they may be considered as in a dead state and incapable of acting upon each other so as to generate a new metal; hence it becomes necessary to impregnate the acid with some inflammable substance, that it may not oxidize the metal. The common oily bodies do not unite with acids, therefore they must be subtiliated, and rendered unitable. The industry of the chemists of the thirteenth and fourteenth centuries was employed in finding out the method of impregnating the acids with inflammable matter, so as to render them capable of dissolving metals without oxidizing them: these researches occasioned the discovery of brandy, alkohol, ether, and the thin oils obtained by the repeated distillation of the common species; all of which were applied to this use, as also the oxalic acid obtained by Guido de Cauliaco from alkohol by nitric acid. The solvents thus obtained, and serving, as they expressed it, for the nourishment of the enfant, were called menstrual solvents, from an analogy with the then commonly received opinion of the use of the menstrual flux in human generation. At the first commencement of this theory, it is probable, that the whole mass of metals to be changed were dissolved and exposed to the re-action of each other; but the phenomena of fermentation soon suggested an analogy, which led the way to those attempts at the transmutation of metals, which are now properly designated by the name of alchemy. Saccharine matter, vinous liquors, acetous liquors, are a series of natural bodies, which are formed from one another in a direct line, only by the action of ferments. A ferment of wine, subtiliated and opened, so as to produce its like, is required to convert saccharine matter into vinous liquor; and in like manner a ferment of vinegar, subtiliated and opened, so as to produce its like, is required to convert vinous liquor into vinegar. This analogy of saccharine matter amongst organic substances, it was supposed, might be rationally transferred to mercurial matter amongst minerals; the mercurial series being quick silver, silver, gold: the first, the substratum of perfect metals; the two others, perfect metals of different degrees of perfection, even as saccharine matter is the substratum of vinous and acetous liquors, and these liquors are the same thing in different stages of fermentation. It was supposed, therefore, that if silver was subtiliated and properly prepared, it would act as a ferment upon quick silver, and transmute it into silver; and in like manner, if gold was properly treated, it would transmute either quick silver or silver into a body of its own nature. These are the grounds of the transmutation of metals, properly so called; the first process for which, appears to be given by Arnoldus de Villa Nova, in his Flos Florum seu Lumen Luminum, The choicest Flower or greatest Light; as also in the Gaudium Arnoldi, The Rejoicing of Arnold. Hence the rise of this theory, and of the true alchemy, as that art is now understood, may be dated between the time of Albertus Magnus, and of Arnold, of whom the first was the preceptor, and the second the pupil of Thomas Aquinas, that is to say, between the years 1240 and 1290, of the Christian æra; and to have been first conceived in the monasteries of France or Italy. Some, however, ascribe it to Morienus, said to be a native of Rome, who was an hermit at Jerusalem, and wrote in Arabic, nearly a century before this time.

Original Process, or Via antiquorum.—The practice founded upon this theory is thus described: an amalgam of copper is dissolved in the menstruum vegetabile, which, from collateral circumstances, appears to be nitric acid, impregnated either with alkohol, ether, or some similar matter. This solution is then digested; a black powder, the caput corvi, or crow's head of the theorists, separates and swims on the surface, which is to be taken off, and the digestion continued until no more feculencies arise, and the solution becomes clear. The black powder thus separated, is to be gradually moistened by successive portions of the clear solution formerly obtained, and each time digested, in an open but tall vessel to dryness. By this means, lavatio Æthiopis, the washing of the Moor, albificatio latonis, the whitening of our copper, it becomes white, collum cygni, the swan's neck. In like manner, another amalgam, either of silver or gold, according as the ferment is required, either for the white work, the making of silver, or for the red work, the making of gold, is to be treated in the same way: then 4 parts of the preparation from copper, and 1 part of that from either of the perfect metals, is digested together, until the matter passing through several successive changes of colour, cauda pavonis, the peacock's train, becomes fixed and of a white or red colour. The white elixir is said to transmute quick silver into silver, and the red to transmute either quick silver or silver into gold, in about the proportion of one part of the powder to fifty of the metalline mass to be changed.

Way of the Separation of the Elements.—The length of time, namely 40 months, taken up by the repeated digestions used in the former method, called the way of the ancients, led Raymund Lully, the pupil of Arnold, to attempt several modes of abbreviation, and to invent a method, which is styled the way of the separation of the elements. The solution of the amalgam in the menstruum vegetabile being completed, he after a slight digestion distilled it, first in a water bath; the volatilized product he called water: then removing the vessel into a bath of wood ashes, and proceeding in his distillation, what came over he called air. When no more arose in this temperature, the vessel was removed to a sand bath, and urged with a stronger heat: the volatilized part he called fire; and the black residuum left in the vessel, earth. This earth he imbibed with successive portions of the water, and part of the air, until it became white and volatile; and this matter being sublimed, he styled sulphur naturæ, or mineral sal harmoniac, so called from the harmony existing amongst its constituents, which renders it not decomposable by heat. To common salt of tartar, he added the fire and remainder of the air, digesting the combination for a few days, until it became a thick but fluid oil, oleum inceratívum. The mineral sal harmoniac being gently heated, he added the incerative oil by degrees, until the salt melted like wax. This being then added to three times its weight of an amalgam of a perfect metal; the combination, on being added to quick silver, will transmute a much greater proportion than Arnold's preparations. Lully also, in attempting to improve the preparation of the menstruum, and to shorten the time taken up in making the digestions and repeated cohobations, proposed a method of abridging distillations, by causing the vapour to pass through ignited tubes: it is well known what great use has lately been made of this invention.

Ripley's and Isaac's Improvements.—The kings of England and France, at length, coalescing upon a point which touched their revenues in so forcible a manner, the Knights Templars, throughout England and the South of Europe, were suddenly arrested, and received the punishment due to their crimes. By this means, the field of commerce was opened for the laity, and in a few years afterwards, the Hanseatic league of the German cities was formed to defend their trade against the remains of the Templars, who being the sovereigns of Prussia, still retained their power in the North of Europe. The power of the temporal governments being thus increased, they were enabled to supply the expenses of the state by regular modes of taxation, without having recourse, unless upon extraordinary occasions, to augmenting the value of their coins above their natural price. This alteration may be regarded as the means of the persecution which chemists laboured under, being at an end, as their apparatus and pursuits were no longer marked out as objects of suspicion.

Hitherto nitric acid had been the basis of the menstruum. Sir, or, as we should now say, the reverend Mr. George Ripley, an English clergyman, first invented the menstruum minerale, and thus introduced the sulphuric acid into alchemy. He also proposed a simplification of the way of the ancients, by omitting the separation of the black powder, and continuing the digestion until the solution became clear, and the powder disappeared, then slowly reducing the whole to dryness. Ripley also proposed the solution of the sulphate of copper in the menstruum, in lieu of the amalgam of copper, as conducive to expedition, and also rendering the powders capable of transmuting a larger quantity of metal.

Isaac, the Hollander, then comes forward as the most industrious chemist. Pursuing the researches of Ripley, he gives numerous processes for shortening the ancient method of transmutation, which show his assiduity in this study, but at the same time demonstrate that he was not a man of education, as he scarcely ever quotes his predecessors, being for the most part self-taught; indeed he seems to have been an artist in the porcelain or painted glass line, and by that means led to cultivate chemistry. Phosphorus and the phosphoric acid seem to have been introduced by him; and he asserts, that if in making aqua fortis from green vitriol, salt petre and cinnabar, the nitric acid be repeatedly cohobated upon the residuum, the acid becomes strongly phosphorescent; and here it may be remarked, that Pott found, that nitric acid repeatedly cohobated on quick lime, emitted an inflammable vapour.

Although Raymund Lully and Ripley had attempted to shorten the processes of Arnold de Villa Nova, they preserved the fundamental parts of the process; but Isaac, and after him Paracelsus, proposed methods essentially differing from that of Arnold. Indeed the succession of master and pupil, which had been continued through the line of Arnold, Lully, Parisinus, Bacon, Ripley, and Rupescissa, seems to have ended with the latter; the necessity for it ceasing at the same time. This succession, and the circumstance that the works of these authors were not intended for promiscuous use, but only for the esoteric information of their pupils, has led them to conceal the identical substance used by them to impregnate the acid; and we can only form probable conjectures respecting it, from the theory, the phenomena which occur, the explanations found in some unpublished manuscripts, and the experiments of Boyle, who was in the habit of publishing alchemical experiments, either without mentioning the circumstance which gave rise to them, or else disguising the cause.

Impulse given by Paracelsus.—Alchemy becoming more known, in consequence of the general increase of learning among the laity, and the increased commercial spirit of the times, to which it is so congenial, was much cultivated at the beginning of the 16th century, and early engaged the attention of the famous Paracelsus. This active empiric formed a design to create an entire new science of medicine, and to supplant the Galenic school, even at the time when Galen was most devotedly followed. His success was considerable, and, in consequence, the extent of chemistry began to be expanded, and two sects of chemists were formed, who, although both alike desirous of improving chemistry, looked upon each other with contempt. The most learned sect, Crollius, Libavius, Barchusen, adhered to the opinions of the alchemists, and united that study with physiology, and the improved pharmacy. A fondness for antiquity made them frequently entertain notions which are rejected at present: and their preconceived opinion of the antiquity of the transmutation of metals, led them into many errors, by causing them to interpret the ancient authors so as to support their own opinion, and to receive many spurious authors as genuine. The other sect was composed mostly of the laborants of the former: chemical remedies coming into common use, these operators deserted their masters, as soon as they had obtained a few common formulæ, and either opened shops, or commenced lecturers on pharmaceutical chemistry, as Beguinus, Le Febure, Glaser, Lemeri, and some others. These men limited chemistry to their own views, and defined it the art of preparing medicines. As this was, indeed, the extent of their knowledge, it was natural for the learned alchemists to treat their opinions with contempt; while, on the other hand, they propagated a thousand falsehoods respecting the others, charging the whole body of learned chemists with those fraudulent tricks which had been practised, not by them, but by swindlers in their name.

Extension of the Via antiquorum.—Some cultivators of alchemy were of opinion, that the elixir might be obtained from all bodies decomposable into the tria prima, phlegm and earth, by distillation; that is to say, from all organic substances, or mineral bodies that yielded similar products by the operation of fire. They endeavoured, therefore, to discover the purest body of this kind, and generally fixed upon May dew, collected by drawing a number of sponges fixed to a pole, along the ground: others chose human blood. These they distilled, and cohobated the volatile matters upon the residua, in the manner already described. It seems probable, that phosphorus, or some phosphuretted metals were obtained in these operose processes, and regarded as the harbingers of success.

Mercurial Sect of Alchemists.—During the hostility of these sects, another was silently rising into estimation, which gradually absorbed all the others, and from which the present chemistry is derived. The first trace of this new sect is the Gebri Espositione of Brachescus, published in 1544. This chemist, studying the works of Geber, which had been condemned by the disciples of Arnold as spurious, because its end was different from theirs, was led to form a new opinion, compounded, as it were, of those of Geber and of Arnold. The former had expressly asserted, in the most positive terms, that metals could only be united with one another, or with volatile bodies of a similar nature, without loss of their metalleity: hence, Brachescus concluded, that solutions of metals in quick silver, and particularly of iron, were far preferable to acid solutions of the metals, with whatever skill these latter might be prepared; the other parts of the theory remaining as in Arnold's works. To obtain the suffrages of antiquity, then thought necessary, Brachescus and his commentator Tauladanus endeavoured to procure the evidence of Geber, and to show, that the supposed old books which described the way of the ancients in highly enigmatic terms, had been mistaken and misapplied by Arnold and his followers, and that they were really to be understood of the phenomena occurring in the digestion of properly prepared amalgams. The black powder that amalgams yield upon being triturated, and the changes of colour that occur during the calcination of them, are alleged as the proofs of this interpretation. This theory of Brachescus was reduced to practice by a pseudonymous author under the assumed name of Philaletha, who is said to have been one Mr. Thomas Vaughan, in his Introitus apertus ad occlusum Palatium Regis, The open Entrance to the shut Palace of the King; the most famous work ever published on alchemy, properly so called. At the same time the writings of Biringuccio, Kretzmers, and John Tholden, far better known by one of his assumed names, that of Basil Valentine, in which much practical knowledge was unreservedly communicated, went through repeated editions; and the pursuit was taken up by Boyle, Becher, Newton, Stahl, and several other chemists of distinguished reputation.

Rise of experimental Chemistry.—It was a fortunate circumstance for the progress of the science, that the attention of its cultivators was thus recalled to the works of Geber and the experimental writers, as it induced a philosophical turn of mind, and a love of research that quickly produced the greatest effects. While, therefore, the disciples of Arnold and Paracelsus were engaged in endeavouring to explain their writings, or in defending the antiquity of the transmutation of metals, or in reducing the practice of medicine to chemical principles; and the shop chemists and lecturers were engrossed solely in preparing chemical remedies for commercial purposes, or in showing their empirical use; the followers of Geber and Tholden were laying the foundation of chemical science, and extending its dominion over the whole of nature. George Agricola related the processes of the metallurgists; Kretzmers and Biringuccio, those of the chemical manufacturers. The Hon. Robert Boyle employed himself in familiarizing chemistry to the general purposes of life, and in showing the utility of chemical researches in almost every branch of natural philosophy, without forming any regular system of it. Dr. Becher, more active, more attached to the peculiar habits of chemistry, proceeded with rapid steps to form it into a science. His Œdipus chemicus explained the terms; his Laboratorium portatile simplified the apparatus; his Physica subterranea displayed the elements of geology and mineralogy; his Concordantia chemica congregated the principal operations of his predecessors into a single body; but his numerous avocations and restless disposition did not permit him at all times to exercise that nice discernment which is necessary to distinguish truth from falsehood. Sir Isaac Newton, in the queries affixed to his Optics, has given proofs of what he would have performed in chemistry, had not the disputes into which he was drawn by the foreign mathematicians, withdrawn his mind in disgust from philosophy, and led him to seek comfort in unravelling the chronology and prophecies of the Jewish priesthood. Dr. Stahl, possessing a cooler head than Becher, using the most solid judgment, and joining the theory of the elements, as promulgated by Becher, with that of their actions, as developed by Newton, gave, in his Fundamenta Chemiæ, a scientific body of chemistry, which will ever remain as a monument of his ability. The English translation of this work, by Shaw, is only of the first part of the first volume; the entire work consisting of two thick quarto volumes: the second is usually wanting, and the second part of the first volume is made to supply its place. Chemistry being thus extended, its cultivators dropped the name of alchemists, and became known by that of experimental or philosophical chemists, in consequence of their pursuits being no longer confined to one or two branches of study.

The celebrated Boerhaave, in his Lectures, of which the translation by Shaw is enriched with useful notes, further extended its limits: and his work, when combined with the Elements of Assaying by Cramer, his operator, is still the best introduction to the practice of the art; and, like the Elements of Euclid, the Optics of Newton, and Bergmann's Essays, ought to be diligently studied by all who wish to acquire the proper mode of conducting philosophical inquiries; a species of knowledge in which very excellent experimental chemists are, for want of due training, very often grievously deficient.

Old chemical Characters.—It remains to say a few words on the old chemical characters, which have been supposed to have been invented and constantly used by the alchemists. The MSS. of some of the Greek chemists are entirely composed of these characters, and seem to have been intended, like the short hand notes of the moderns, for the private reminiscence of the original writer only, or at most, for that of his immediate disciples; but although they were thus used by the clerical chemists of Egypt, yet none of these writings seem to have been much known in the West until the taking of Constantinople by the Turks; and no traces of the use of these characters are to be found in the writings of Arnold, Lully, or any of that school. In most of the copies of Lully's works, Roman capital letters are, indeed, used to designate peculiar terms or phrases, of which designations an alphabetical list is added, either at the beginning or end of the book; but whether they were used by him in his autographs, or merely invented by the stationers to save their labour, on considering the excessive flood of words which distinguish his writings, is unknown. The followers of Paracelsus appear to have been the first occidentals that used these Greek characters, and that almost entirely in pharmacy. Their great inconveniency in printing caused their disuse, and they were soon reduced to the mere ornamenting of the bottles in a pharmacopolist's shop window. Tables of elective attractions brought them again into play; but neither their former, their present, nor even their probable future use is of much consequence, although they have formed the basis of illiberal reflections being cast upon those who never used them. The chemists of the present day, as we have already observed, have taken up the use of initial letters, when they wish to be concise.

Possibility of transmuting Metals.—Such are the results of inquiries into the doctrines and practice of the ancient alchemists. The high station and literary reputation of several among them, forbid us to suppose them capable of deceiving the world, when they write in a positive manner. As to the vulgar stories and canting histories of processes communicated by friers or hermits, or of powders found in the covers of old books, or in the cells of monasteries, these may be pronounced at once to be falsities, trumped up for swindling purposes. The history related in the Golden Calf of Helvetius, first published in 1667, is, however, usually regarded as an unexceptionable testimony in favour of the existence of a powder capable of transmuting a large proportion of lead into gold. Having, in a work written against Sir Kenelm Digby's sympathetic powder, expressed his doubts of the possibility of transmuting the metals, Helvetius was visited by a stranger, who, to convince him of its possibility, gave him a small piece, about half the size of a rape seed, of a yellow stone, with some directions for its use, by following which, Helvetius did, in private, transmute upwards of six drams of lead into gold. The attention paid by such men as Boyle and Stahl, to the solution of the problem, is sufficient to justify those who may be induced to labour on it. The discovery of a method to ascertain the longitude of a ship at sea, has been classed in the same predicament with that of making gold, and the wits of Queen Anne's age, who thought,

"The proper study of mankind, is man"—Pope.

alone, and levelled the shafts of irony and bantering on all who attended to the natural sciences or mathematical studies, did not spare those who bestowed their time on that subject. But the mathematicians bore up against their sneers, and have succeeded in a considerable degree.

Boyle has published a singular experiment, which shows the great alteration producible in gold, usually esteemed the least likely to be altered of any metal, by an extremely small portion of another substance: 2 drams of grain gold were melted, and about an eighth, or rather one tenth of a grain of a dark red powder, which had been given to him, was added; it was kept for a quarter of an hour in the fire, and then poured out into another crucible, where it looked at first like pure gold, and after a while, like an opal, but when cold, appeared to be a lump of metal of a dirty colour, and, as it were, overcast with a thin coat almost like half-vitrified litharge. A piece of metal, very like silver, stuck to one side of the crucible, and its bottom was overlaid with a glassy substance, one part of which was transparent yellow, the other was deep brown inclining to red, in which were 5 or 6 globules like impure silver. The changed metal made on the touchstone a streak more like silver than gold. It was brittle, and the inner surface resembled bell metal rather than silver or gold. The specific gravity was diminished to 15 and one third: a dram being cupelled with 6 drams of lead, lost 7 gr. but this was made up by the dark colour recrement, which was surprisingly heavy and fixed; the cupel was smooth, entire, and tinged of a fine purplish red. He concludes with these words, "Yet have I not, because I must not do it, as yet acquainted you with the strangest effects of our admirable powder." These mysterious words, and the phenomena, denote that this powder was indeed an elixir for the red work, and that the real object of the experiment was, in alchemical language, to exalt the gold into an elixir itself. Wilson has related at the end of his Course of Chemistry, several alchemical experiments made by him, partly at the expense of a friend; in one of which he obtained ℈ij, gr. xiij, of gold, and missed ʒj, ℈j, gr. xvij, of silver; but these were omitted by Dr. Lewis, in the later editions of that work, published by him. Boerhaave has not scrupled to insert a special defence of the genuine alchemists in his Elements, and it is well known that he laboured much in that field. The satire of Addison, Steele, Swift, and their tavern companions, who were haters of scientific acquirements, and considered nothing worthy the attention of a man of education, but the mere study of the three learned professions, the art of agreeable conversation over a bottle, or rather a dozen of wine at a tavern, or the management of party squabbles, prevailed; and the relations of the changes produced in metals, were proclaimed to be equally false with those of the falling of stones on the earth, the spontaneous combustions of the human frame, the collection of lightning from the clouds, by the Tuscan and other priests; a most dangerous experiment, to which one of the early kings of Rome, Tullus Hostilius, as also, in all probability, Romulus, and Moses the Jewish lawgiver, had fallen victims; and which, in our own times, has been fatal to an experimenter in Russia. The latter phenomena are now no longer disputed, although the first be, at least in promiscuous company, derided. Dr. Bryan Higgins, as appears by the Syllabus of his Chemical and Philosophical Inquiries, openly defended, in 1775, the alchemists, but cautioned his auditors, the principal scientific chemists then in the metropolis, against the dangers of alchemy, in relation to the hazard of being drawn on by degrees into greater expenses than they should prudently bestow upon a problem of such difficult solution.

Dr. Price's Experiments.—An operating pupil of his, Dr. James Price, in May 1782, made some experiments with a white and a red powder, in the presence of several noblemen and gentlemen, who provided most of the materials employed, or took the requisite portion from a larger quantity in the laboratory. The white powder, rubbed with quick silver and a few drops of sulphuric ether in a mortar, rendered that metal grouty, and on being heated pure silver was obtained. The same change took place on adding the white powder to boiling quick silver. In like manner the red powder changed quick silver into gold. The quantity of silver or gold obtained was about 50 times the weight of the powder. The purity of the perfect metals was ascertained by the ordinary assay masters, and also by Dr. Bryan Higgins, his former instructor. At that time I assisted in the laboratory of Dr. Higgins as his operator, and he dictated to me a letter to Dr. Price, expressed, so far as I can now recollect, in very cautious language, and in which Dr. Higgins, if my memory does not deceive me, observed, that if a combination of sulphur, mercury, and copper, be made to enter gold, the alloy cannot be detected by the ordinary mode of assaying. The original memorandum, made at the moment on the margin of Macquer's Chemical Dictionary, is, from the sale of that book, no longer in my possession. As the prepossession against the possibility of all the above mentioned singular phenomena was at that time in full vigour, and the experiments had been performed at a country town, a few miles distant from the metropolis, the leading chemists of the capital remain unconvinced. Dr. Price stated in his publication that he had expended his stock in these trials, and could not furnish himself with a new parcel, but by a tedious process, which he had found to have an injurious effect on his health. Mr. Galt, in the Appendix to his Life of Cardinal Wolsey, states, from hearsay evidence, that Dr. Price used some duplicity in this affair, not in the experiments themselves, but in asserting that he had made the powder himself: on one occasion, he stated the powder cost him 17*l.* the ounce, and on another, that he procured it from a foreigner, to whom he gave 60 guineas for the parcel, with a solemn promise not to make a public experiment with either of the powders, and that he expressed his sorrow for having transgressed in this particular. Whether this breach of promise affected his mind when he found the animadversions to which it had subjected him, and which he could not repel, from being ignorant of the process to make a fresh parcel; or whether, as some affirm, he was making medical experiments on poisons, he died in August 1783, after a short illness, from a dose, as it is said, of cherry laurel water.

Present State of Alchemy.—Since which, the investigation of the gases, first noticed by Van Helmont, and the analysis of mineral substances, have principally occupied the attention of chemists. The problem of the changing of the metals has been left at rest, except by those who labour only for themselves, and keep their inquiries a profound secret. It were to be wished, that these gentlemen would publish their experiments. Dr. Hampe, following the example of Wilson, has, indeed, given the world his Experimental History of Metals, but we cannot determine how much of it has been verified by his own experience. Peter Woulfe is well known to have experimented considerably on the subject, but has published nothing of the kind; and Pott, in the course of 50 years' labour, had repeated all the experiments of the ancient chemists, as literally delivered, without those additions which are said, by the theoretical writers, to be necessary; but upon Margraaff having been preferred in the Prussian Academy before him, he destroyed, as we are informed by Thiebault, in his Souvenirs, all his notes of those experiments. Of the value of the experiments, and of the carefulness of Pott, we may form some judgment from his Lithogeognosie, in which he relates his experiments upon earthy and stony substances; experiments as valuable in a technical view, as the analyses of minerals are in a philosophical. It may, indeed, be said with truth, that we are less acquainted with the most common mineral substances in the shops, than with the rarest. The solitary fact of the metallization of ammonia, as it has been called, and which was alluded to before, is the only experiment which has lately been made that has any relation to the subject of a change in metals. The last public notice taken of alchemy, was an advertisement about a year ago in the Times paper, by a person near London, who offered to teach the art of making silver, on receiving a considerable sum of money, of which one half was to be deposited previous to any conversation on the subject, and the most solemn promises of secrecy exacted. The magnitude of the deposit to be made to an unknown person, would naturally cause it to be considered, by the generality of mankind, as a swindling affair; and, in a subsequent paper, the end of April 1822, the apparatus was advertised for sale. About this time, a metal, or alloy, resembling silver, was also sold to some silversmiths.

Silver.—Silver, like gold, is frequently found native in the earth, or it is extracted from copper and lead, which mostly hold a certain proportion of it, and generally in sufficient quantity to pay the expense of its extraction. From copper, it is separated for sale, by melting the metal with a certain proportion of lead, and casting it into flat cakes, which are then placed in the chamber of a reverberatory furnace and gradually heated: the lead soon melts, and the union of lead and copper being very slight, it drains from the cakes and carries the silver along with it. Some ores are ground with quick silver, which unites with the silver, from whence it is afterwards separated by distillation in iron vessels. Lead holding silver or silver and gold, has the lead converted into litharge, and the perfect metals left in the vessel. When this operation is performed in small, for a trial or assay, the vessel is made of the ashes of fish bones pressed in a mould into the shape of a saucer, and the fire is kept up so that the melted oxide forms spots like oil on the surface of the metal, which running to the edge, should form there only a very narrow ring: the breadth of this ring is an accurate measure of the proper temperature. When the last portion of the lead is oxidized, the pure silver suddenly appearing as the thin varnish of the oxide of lead leaves it, makes a kind of flash; and as it requires a greater heat to keep it in fusion, it immediately setts, and throws out tree-like excrescences, or even projects a part of its mass to a small distance. This cupellation of silver is one of the best modes of acquiring the management of a naked fire, as the required degree of heat is marked as determinately as by a thermometer. Silver is used, like gold, to ornament pills, but is so extremely apt to tarnish, that it can only be employed for those to be taken immediately. Quick silver unites rapidly with it, and the lustre thus produced is a good test of the presence of uncombined quick silver in any powder, or liquid, however small in quantity. Some persons use quick silver, diffused through fine earthy powders, to clean plate; it gives a brilliant whiteness at first; but as the quick silver gradually diffuses itself through the whole mass, this brilliancy disappears, and the silver becomes so brittle as to break by a fall. The amalgam of silver is denser than the heaviest of its ingredients, sinking in quick silver.

Platina—Is a granular ore brought from South America: its principal constituent part is a white metal named platinum, or white gold, of which it is the sole source, as also of palladium, rhodium, osmium, and iridium.

Speiss, or Nickel—Is a metal obtained from an ore resembling copper. It is roasted to separate the sulphur, and then melted with charcoal; the regulus thus obtained is again roasted and reduced, but is still impure, although it is principally nickel, and sold for it.

Manganese.—A black mineral used in glazing pottery, is called manganese, in Latin magnesia nigra. It is the peroxide of manganese, and as it parts with a portion of its oxygen very easily by a red heat, it is now used for furnishing oxygen gas, of which it yields about one tenth of its weight.

Zaffre.—A gray powder is imported from Saxony by the name of zaffre; it is a combination of oxide of cobalt with silica, and is obtained by melting the oxide with sand.

Smalt.—Smalt is a similar combination, of a fine blue, in gross particles, obtained by re-melting zaffre with fine glass to dilute the colour.

None of these are employed as medicines, but they are used in chemistry to obtain the metals they contain.

Sulphur.—Sulphur, or brimstone, is found native, and also extracted from several ores. It is yellow, and burns with a blue flame and suffocating odour, occasioned by the formation of sulphurous acid by its union with the oxygen of the atmosphere. It is very nearly twice as heavy as water, melts at 224° Fahr. and, in close vessels, sublimes at 600°: water has no action on it. Sulphur is laxative in doses of ʒj or ʒij; it is particularly useful in piles, and the itch. In the last disorder it is also employed externally. When volatilized, and its vapour passed through a red hot tube filled with charcoal, it forms Lampadius' alkohol of sulphur, or the sulphuret of carbone; a transparent colourless liquid, of a pungent taste, and peculiar fetid odour, whose composition is C + 2 S.

Sulphur mixed with iron filings and made into a paste with water, rapidly absorbs oxygen from the air, and leaves the nitrogen pure; hence it was used as an eudiometer, while the uniform composition of the atmospheric air was unknown.

Sulphur rubbed with an equal weight of quick silver forms a black powder called Æthiops mineralis, or hydrargyri sulphuretum nigrum, used gr. x to ʒſs, as an alterative in cutaneous diseases. If this powder be projected into heated earthen sublimers, the superfluous sulphur allowed to burn out, a tile then placed on the mouth, and the heat increased, a sublimate is obtained, which when powdered is of a fine red: the minium of the ancients, and vermilion of the moderns; called also, the red sulphuret of quick silver, or more accurately, the bisulphuret of that metal: it is employed as a fumigation to heal venereal ulcers. When this sulphuret is heated with iron, the sulphur unites with that metal and lets go the quicksilver, which passes over in distillation in a state of great purity.

The presence of sulphur in the air is shown by the rapid tarnishing of silver, the tarnish being the sulphuret of that metal.

When silver holds a very small proportion of gold, this latter may be separated by melting two thirds of the mass with sulphur, gradually evaporating the sulphur to a certain point, and then adding the remaining third, which as it passes through the sulphuretted silver collects the gold. By several repetitions of this dry parting, a single part of gold has been separated from 384 of silver, in the way of trade.

Cinnabar.—A natural sulphuret of quick silver, called cinnabar, is found in some countries, and is the principal source from whence quick silver is obtained. That of Almaden in Spain is mixed with a calcareous stone, so that it requires no addition of iron to separate the quick silver, as the lime itself unites with the sulphur, and retains it while the metal distils over. The cinnabar of China is purer, and being superior in colour to the Dutch artificial cinnabar or vermilion, is imported in powder for painting, by the name of Chinese vermilion.

Oil of Vitriol.—Oil of vitriol was formerly in England, and still is in Germany, prepared from the green or blue vitriol, by distillation with a violent heat, continued for several hours. The liquid now sold by that name, was then called oil of sulphur by the bell glass, and was prepared by the chemists themselves; at present, it is sold as a mineral product, so cheap, and the operation is so troublesome, that from a product it has become an article of the materia chemica. It was originally made by burning sulphur under glass bells, whose inner surfaces were kept moist by being suspended over warm water; the sulphurous acid impregnated the vapour condensed in the bell, and trickled down into a vessel placed to receive it; it was then exposed to the atmosphere, to absorb oxygen from the air, by which it was converted into sulphuric acid, and then concentrated by evaporating its superfluous water. At present, it is prepared by a quicker but more operose process: the sulphur is mixed with one eighth or tenth part its weight of salt petre, and burned in vessels or rooms nearly closed, floated with water, and having only an aperture at the top to admit air: by this addition, sulphuric acid is obtained at once; or, the sulphur is burned by itself, and some plates of nitric acid placed in the condensing room, to supply the nitrous gas that is necessary for obtaining sulphuric acid, instead of sulphurous from sulphur. This method is more expensive, but produces a purer acid than that with salt petre. The dilute acid thus obtained is concentrated in platina stills, or in glass retorts, with a few slips of platina to moderate the boiling, until it is 1·845 times as heavy as water. It is of an oily appearance, whence its name, and is supposed to consist of S^3 + water.

Water, gently poured upon oil of vitriol, remains separate for a long time, but on stirring them together they unite, much heat is evolved, and the mixture is extremely sour and rather astringent. The strong acid is used externally as an escharotic, in fresh wounds; and three measures diluted with 29 of water, is used internally, gtt. x, or more, in a large proportion of water, as a tonic and cooling medicine.

The strong acid, boiled on copper, silver, tin, quick silver, and lead, to dryness, is decomposed: part of its oxygen unites with the metal; the oxide thus produced, combines with the undecomposed acid, and the salt may be dissolved by water; while the decomposed part of the acid, which has lost a portion of its oxygen, flies off in the form of a gas, called sulphurous acid gas.

The diluted acid dissolves iron or zinc very quickly, evolving a large quantity of hydrogen gas from the water that is decomposed, by its oxygen uniting with the metal. The sulphate, or rather sulphurate of iron, thus obtained, being crystallized, is used, gr. j to v, as a tonic and emmenagogue; as also, redissolved in water, as a clyster, against ascarides; and the sulphate of zinc is used as an emetic.

Sulphurous Acid.—Sulphurous acid, or S^{I}, is prepared by the chemists by distilling oil of vitriol on quick silver or tin; but for business, chopped straw or saw dust is used. The gas thus produced is absorbed by water. This acid is used in bleaching, and was formerly in the Pharmacopœia, under the name of gas sulphuris. Sometimes it is used in the aëriform state, as when sulphur is burned in a closet and straw plaiting exposed to the gas, to renew the brilliancy; or when sulphur is burned in a hole made in the ground, and a hive of bees put over it to kill them.

Hydrogen Gas.—The hydrogen gas obtained in the above processes is the lightest gas yet discovered, as a gallon weighs only about 5 grains; its specific gravity is to that of common air, as 0·0694 to 1. Hence it is used to fill balloons for aërial navigation; each cubic foot, making allowance for impurities in the gas, being capable of buoying up an avoirdupois ounce; from which buoyancy, the weight of the balloon and apparatus must be deducted, to find the weight it will actually carry. What might be its specific gravity in a solid state is unknown, nor have we any data on which to calculate it. When made to issue through a narrow orifice and set on fire, it burns with a dull yellowish white flame, without any smoke, yielding only pure water, which is formed, according to the hypothesis at present in fashion, by the hydrogen decomposing the air, and uniting with the oxygen, setting the azote free; the water is of course of greater weight than the hydrogen gas, by the weight of the oxygen that enters into its composition.

Green Vitriol.—The wiktrils, as they are called by those who speak common English, and as the word is still written in the northern regions of Europe, are by authors, and those who learn the English, although it be their own language, by books, written vitriols, apparently a vulgar Latin word, introduced into chemistry, by Angelus Sala, a diminutive of vitrum, as hordeolum from hordeum; the older authors denominating copperas, or green vitriol, chalcanthum. It is found native, but is principally manufactured from the native bisulphuret of iron, called brass balls, or horse gold, which is gently roasted, and exposed to the weather, although some kinds do not require any roasting. The vitriol oozes out on the surface, is washed off by the rain, and the solution collected in cisterns, containing scraps of old iron to saturate the excess of acid, is evaporated and crystallized; the colour is green, more or less deep, and it is the hydrated sulphate of the protoxide of iron, or $S^3 I^1 + 7$ water, as it contains about 29 per cent. of the acid, 26 of protoxide of iron, and 45 of water. It is used in the arts, and when recrystallized, with the addition of a little sulphuric acid, is employed in medicine, instead of that made directly from iron and the acid.

Blue Stone.—Blue stone, or blue vitriol, is a hydrated sulphate of the binoxide of copper, obtained from the water in copper mines, where it is formed by the action of the sulphuric acid, produced in roasting the ores upon the metal. It contains about 33 per cent. of acid, 32 of peroxide, and 35 of water; so that its composition is $2\ S^3 C^2 + 10$ water. Of late it has also been manufactured by boiling oil of vitriol upon copper shreds, dissolving the salt thus formed in water and crystallizing it. Blue stone is used in surgery as a caustic, and also in medicine, gr. v, as a vomit, acting almost instantaneously, and requiring but little effort.

White Vitriol.—White vitriol is manufactured from the sulphuret of zinc, called blende. It is a hydrated sulphate of that metal, resembling loaf sugar in appearance, like which it is made up into conical loaves, and contains much water. It is used as a cheap and efficacious vomit, but sometimes produces a spasm of the stomach that defeats its action. As it contains a little iron, and sometimes copper or lead, it should be purified for medical use by being dissolved in water, boiled with turnings of zinc, to separate the other metals, and the solution then filtered, evaporated, and crystallized. As the pure salt contains about 31 per cent. of acid, 33 of oxide, and 36 of water, its composition seems to be $S^3 Z^1 + 5$ water.

Alum.—Alum is a salt obtained by roasting a slatey stone, used by the poor as a remedy for bruises, under the name of Irish slate. This is burned, and after exposure to the weather, is washed with water; the solution has some wood ashes and urine added to it, and then it is evaporated to a certain point, and poured into barrels, where it crystallizes in large masses, and is hence called rock alum, to distinguish it from Roche alum, which is imported from Rocca in small lumps. Alum is a triple salt, composed of about 37 per cent. of sulphate of alumine, 18 of sulphate of potasse, and 45 of water, with a small quantity of ammonia. Alum is astringent, and used both internally, gr. v to xv, or externally in gargles, eye waters, and injections. Burnt alum, or, more properly, alumen exsiccatum, is alum from whence the water has been driven by heat, and is used in surgery as an escharotic. The liquor aluminis compositus is a solution of equal parts of alum and white vitriol, in about 30 times their weight of water; it is used in dressing wounds, and diluted, as an eye water.

Salt Petre.—Rough salt petre, brown petre, or nitre, is obtained by washing certain earths with water, and evaporating the liquid, by which means a brown impure salt is obtained. This being dissolved afresh in water, the solution evaporated and strained, as soon as a drop, taken on a pane of glass, exhibits needle-like crystals when it cools, is set by to crystallize. The remaining liquor poured off, is again evaporated to one half, strained to separate the common salt, which the same earth also furnishes, again crystallized, repeating these operations until no more refined salt petre, white petre, or sal nitri, can be procured, and the salt petre has attained its proper whiteness. A single solution, however, in water is sufficient to separate the sand in the rough salt petre; after which, cold water, just sufficient to float the salt petre, left on it some time will abstract all common salt. Where no native salt petre earth is procurable, as in France and Germany, artificial nitre beds are made of old mortar rubbish, mixed with animal and vegetable matters, moistened with urine, and exposed in thin walls under sheds to a free current of air; after some time salt petre is formed, and may be separated by washing with water: generally these artificial beds require the addition of the ashes of vegetables, to supply the alkali, and decompose the nitrate of lime, that is usually formed. Salt petre itself is a nitrate of potash, containing about 53 per cent. of nitric acid, and 47 of potash; that is, $N^5 P^1$, according to Davy, or $N^6 P^2$, according to

Berzelius. Salt petre has a remarkable power of diminishing the action of the heart and arteries ; hence it is used in small doses of gr. v to x, frequently repeated, in inflammatory diseases.

Salt petre exposed to a slight heat, and poured into brass moulds, is called crystal mineral, which is used as a lozenge to stop the progress of inflammatory sore throat; whence its medical name of sal prunellæ, that is to say, sore-throat salt.

By a red heat salt petre is decomposed into azotic gas, oxygen gas, and potasse, which last remains in the distilling vessel.

Salt petre is not altered by the air; it dissolves in about 7 times its weight of cold water, and in rather less than its own weight of boiling water ; hence its solution, when boiled down until it is saturated, affords a plentiful crop of crystals by cooling.

Salt petre mixed with one third its weight of charcoal dust, and fire applied to it, detonates and the azote flies off, while the carbone uniting with the oxygen that was combined with the azote, forms carbonic acid, which remains combined with the potasse, and forms a carbonate of potasse, called nitre fixed by charcoal. A mixture of about 76 lb. of salt petre, 15 of charcoal, with 9 of sulphur, is used in modern warfare as an explosive propellent, under the name of gunpowder.

Salt petre heated with metals, oxidizes all of them, even gold itself; and in this case, as no carbonic acid is formed, the potasse is left in a purely alkaline state, mixed with the oxide, and called nitre fixed by metals.

When salt petre is mixed with an equal weight of common antimony and melted, it forms crocus metallorum, which, when well washed, is an impure sulphuret of antimony, used by the ferriers as an alterative. With three times its weight of salt petre, not only all the sulphur is consumed, but the metallic part is converted into a peroxide, called diaphoretic antimony, having been given in small doses with that intention.

If salt petre be distilled with its own weight of oil of vitriol, it is decomposed : the sulphuric acid unites with the potasse, and the nitric acid being separated is volatilized and distils over ; the remaining salt, when dissolved in water and crystallized, is the potassæ supersulphas of the London Pharmacopœia, used as a cooling purgative; it is soluble in wice its weight of water, and is a bisulphate of potasse, or

$2 S^3 P^2$. For commoner purposes, an impure nitric acid, called aqua fortis, mixed with some sulphuric and muriatic acids, is obtained by distilling salt petre with an equal weight of green vitriol; which last is sometimes dried until it is yellow, in order to obtain a stronger acid. The sulphuric acid is got rid of by distilling the aqua fortis from fresh salt petre; and the muriatic acid, by dissolving some silver in a portion of the impure acid, and dropping this solution into the remaining acid, as long as a precipitate is produced; after which the purified acid is poured off the sediment; the silver contained in this sediment, which is the muriate (or chloride) of silver, may be obtained again by boiling it along with some pieces of iron, in water. The red mass that remains in the retort, is washed to separate the sulphate of potasse, or sal enixum, which is recovered by evaporation, for the use of manufacturers; and the remaining oxide of iron is used as a polishing powder by the name of crocus martis, which name is given it on account of its red colour.

The purified nitric acid for medical purposes is brought to the specific gravity of 1·5, by adding either stronger acid or distilled water, as shall be requisite.

Nitric Acid.—Nitric acid dissolves with rapidity lead, copper, iron, quick silver, zinc, bismuth, silver, and nickel; part of the nitric acid is decomposed, the oxygen uniting with the metal, while the remainder, reduced to a gaseous oxide, is emitted, and is now called nitric oxide, but formerly nitrous gas: this gas unites immediately with the oxygen contained in atmospheric air, and composes nitrous acid, which appears in the form of red fumes. The nitric solutions of lead, quick silver, zinc, bismuth, and silver, are like water and crystallizable. That of lead is used to impregnate wooden sticks, which being ignited at one end, consume gradually, and are employed by the French to fire artillery instead of quick match The crystallized nitrate of copper being moistened and wrapped up in tin foil, much heat is produced, red fumes of nitric oxide are emitted, the foil is burst open, and usually takes fire. The nitric solution of quick silver, by evaporation until it no longer emits red fumes, affords red precipitate, or the hydrargyri nitrico-oxydum, used as the common red oxide, but more frequently as an escharotic and stimulant. The solution of bismuth is precipitated by distilled water, and forms magistery of bismuth; perhaps a subnitrate of that metal, which has been lately used in gastrodynia. The crystallized nitrate of silver was formerly employed as a hydragogue, under the name of lunar crystals; now, the lunar caustic is alone used, which is made by evaporating the solution until it flows like oil, when it is poured into moulds made by sticking a tobacco pipe into clay. This fused nitrate of silver contains about 64 per cent. of silver, it is applied externally as a caustic, or made into an injection about gr. ij to the ounce meas. of distilled water; it is also administered internally in very small doses of gr. fs, to gr. iij, in chorea and epilepsy, but is attended with the great inconvenience of sometimes rendering the skin purple, even after its use has been abandoned for some time. The action of nitric acid on tin and antimony is so violent as to reduce them to oxides, insoluble in the remaining decomposed acid. No effect is produced on solid gold; but if the acid be boiled upon gold in fine particles, a little is dissolved.

Nitrous Gas.—The nitrous gas obtained in making the above nitrates, may be collected and preserved over water; a gallon of it weighs about 86 grains; it contains 29·652 per cent. of azote, and 33·888 of oxygen, whence it is called a deutoxide of azote. If 80 measures of it be mixed in a wide tube over water, with 100 meas. of common air, it absorbs all the 21 meas. of oxygen contained in the latter, red fumes of nitric acid are produced, which are dissolved in the water, and the 79 measures of pure azotic gas, which were contained in the common air, remain in the tube. Many circumstances tend to produce slight variations in repeating this experiment, and these were formerly esteemed as showing the comparative healthiness of places; but more accurate experiments have demonstrated that atmospheric air is an uniform chemical compound. Charcoal ignited in nitrous gas, by a burning glass, changes it into equal measures of carbonic acid and azote, by the oxygen shifting from the latter to the carbone. Nitrous gas is not respirable, but when exposed to iron filings, half its oxygen is absorbed by them; and although the gas is reduced to half its bulk of a protoxide, called gaseous oxide of azote, or intoxicating gas, it is rendered in some measure more respirable, and even exhilarating. Some other metals, as zinc, when heated in it, abstract all the oxygen, and reduce it to half its bulk of azotic gas. A gallon of intoxicating gas weighs about 108 grains, but of azotic gas only 69 gr.

Azotic Gas.—Azotic gas immediately extinguishes a lighted taper, kills animals immersed in it, and is very slightly absorbable by water. It does not unite by mixture or absorption with any of the preceding substances, and is indeed one of the most unmanageable subjects of chemistry. Berzelius considers it as the nitric suboxide, that is to say, N^{1}.

Common Salt.—Salt is abundantly formed in large beds in the earth, and then called sal gem, or rock salt. It is also procured from salt springs and lakes; as also, from sea water, from which it is obtained, either by spontaneous evaporation, when its cubical crystals aggregate together into hollow pyramids, which is called bay salt, sal niger; or by boiling down as long as it yields any crystals, which being collected by a ladle pierced with small holes, through which the liquor may drain, are called white salt, but this is less pure than the other two sorts, and contains a portion of muriate of magnesia. Common salt, when pure, is esteemed by some a muriate of soda, holding 46 per cent. of muriatic acid and 54 of soda, $= M^{2} + S^{2}$; and by others, a chloride of sodium, holding 59·5 of chlorine and 40·5 of sodium, $= C + S$. When pure, it does not alter in the air, unless the air is very moist; hence walls and houses are built of rock salt in some countries where rain is scarcely known; but when it contains muriate of magnesia, it soon runs to a liquid. It is soluble in rather more than 2·5 its weight of water, either hot or cold, and hence it must be crystallized by continued evaporation, and not by cooling its hot saturated solution. When flung upon lighted charcoal, or any fire, it gives a greenish blue tinge to the flame; and hence, probably, it has, like sulphur, been used in religious ceremonies, and esteemed a sacred substance. Common salt is used as a stimulant, not only internally, but also externally, in poultices and lotions, to cause the absorption of indolent tumours, and scrofulous enlargements of glands. Animals also use salt as a stimulant; even wild beasts resort to places where the ground is impregnated with it, and which are known to the American hunters by the name of salt licks. Kine take about an ounce a day, to keep them in good health, horses about 5 drams, sheep 2 drams; pigeons also use it. The salt thus taken promotes digestion: whence, 12 lb. of salted hay is esteemed equal to 16 lb. of unsalted;

and oats, wetted with brine, are completely digested by horses.

When common salt is distilled with five sixths of its weight of oil of vitriol, and a quarter of its weight of water, into two thirds its weight of water, the sulphuric acid displaces the muriatic, which passes over, and being absorbed by the water in the receiver, forms Glauber's spirit of salt, or common muriatic acid, whose specific gravity, for medical use, ought to be 1·16. With the above proportion of ingredients, the residuum is Glauber's sal mirabile, or simply, Glauber's salt, being the sulphate of soda with an excess of sulphuric acid; this excess of acid rendering the salt more soluble in water, occasions the distilling vessels to be the easier freed from it, and may be separated by crystallization. On the hypothesis of chlorine, part of the water is decomposed, its oxygen unites with the sodium, and forms soda; while the hydrogen uniting with the chlorine, forms the muriatic acid which, Gay-Lussac calls, by reason of this hypothesis, the hydrochloric: as the sulphuric acid unites with the new-formed soda, the new-formed acid is expelled from the mixture. Glauber's salt was a common cathartic, in doses of an ounce, but is rapidly giving way to Epsom salt. Gold melted with Glauber's salt, is changed into a red powder, by a proper heat, otherwise it runs through the crucible like water through a sponge. This powder, added to melted silver, changes an equal weight of the silver into scoria, and the remaining silver is found to have absorbed all the gold. Silver is also soluble in Glauber's salt by fusion, in a proper degree of heat.

If 50 parts, by weight, of quick silver, be boiled in 70 of oil of vitriol to dryness, 62 parts of a white sulphate is obtained, which being triturated with 40·5 of quick silver and 34 of common salt, and sublimed in a strong heat, yields the Apothecaries' Society stock, according to Mr. Brande, from 95 to 100 of calomel. On the muriatic theory, the common salt is decomposed by the sulphuric acid of the sulphate, which unites with the soda, and forms the residuum; while the freed muriatic acid unites with the oxide of quick silver, and forms a muriate of the protoxide of that metal, which is sublimed. On the chlorine theory, the oxygen of the oxide of quick silver in the sulphate, unites with the sodium of the common salt, and forms soda, which joined with the sulphuric acid, composes the residuum; while the quick silver, being thus reduced to its metallic state, unites with the chlorine that is set free from the common salt, and forms the chloride of quick silver, called calomel. This substance, as it is scarcely soluble in water, should be called an improper salt or subsalt to distinguish it and similar compounds from the proper salts which are very soluble in water. It may also be obtained, by adding to a solution in nitric acid of quick silver completely saturated by boiling the acid on the metal, a solution in water rendered sour by spirit of salt of half as much common salt as there was quick silver used; the calomel is immediately precipitated. The theory of this operation is the same, only changing the words sulphate and sulphuric acid into nitrate and nitric acid, and sublimed into precipitated.

If common salt be added to a solution of silver in nitric acid, luna cornea is precipitated; formed, according to some, by the muriatic acid of the common salt quitting the soda, and uniting with the oxide of silver contained in the solution, at the same time that the nitric acid unites with the soda, and forms the nitrate of soda, or cubic nitre, that remains dissolved in the water; the muriate of silver falling down as being insoluble: but others say, the oxide of silver is decomposed, its oxygen uniting with the sodium in the common salt which they esteem a chloride of sodium, and thus forms soda which unites with the nitric acid; while the chlorine of the common salt unites with the deoxidated silver, and forms the chloride of silver, as they denominate the luna cornea that is thrown down.

Eight parts of common salt, distilled with 3 of the black oxide called manganese, 4, by weight, of water, and 3 of oil of vitriol, the coloured gas, called oxymuriatic acid gas, and now, generally, chlorine gas, may be collected over water, by which, however, it is very soon absorbed; in cold weather, it crystallizes on the inner surface of the jar. The rationalists say, that one of the charges of the oxygen in the manganese oxide, unites with the muriatic acid, and the oxygenized acid, from its volatility, makes its escape as gas, while the remaining oxide and the soda unite with the sulphuric acid. The Epicurean school assert, that the superabundant oxygen of the manganese oxide unites with the sodium, contained in the common salt, and forms soda, which unites with part of the sulphuric acid, and the chlorine or remaining part of the common salt is set free: the residuum, of course, is partly Glauber's salt, or sulphate of soda, and partly a sulphate of an oxide of manganese, which contains a charge of oxygen less than the black oxide of that metal.

When 8 parts of common salt are ground with 4 of quick silver, on which 5 of sulphuric acid have been previously boiled to dryness, and the mixture exposed to heat, a hard sublimate, called, from its extreme acridness, corrosive sublimate, is obtained. Here, some say, the quick silver is reduced to a sulphate of the peroxide of that metal, which oxide uniting with the muriatic acid of the common salt, forms corrosive sublimate, or a muriate of peroxide of quick silver; while the sulphuric acid uniting with the soda, forms Glauber's salt, which constitutes the residuum: others think, that 2 charges of the chlorine in the common salt, unite with one of quick silver, forming a bichloride of quick silver, or the corrosive sublimate; while the sodium of the common salt, reduced to soda by the oxygen of the peroxide of quick silver, and uniting with the sulphuric acid, forms sulphate of soda, or Glauber's salt.

Muriatic Acid Gas.—Muriatic acid gas is the purest form of the muriatic acid, which in the various spirits of salt is combined with an excess of water. Even the gas itself is conceived, by most, to contain one fourth of its weight; the other part being a binoxide of a supposed element, called by Berzelius, muriaticum, or M^2 + water; while others conceive it to be a simple union of chlorine with hydrogen. A gallon of muriatic acid gas weighs about 92 grains; it extinguishes flame; and 480 measures are absorbed by one of water, augmenting its density to 1·21.

Muriatic Acid.—Muriatic acid, or spirit of salt, is generally yellow, from a small portion of iron it contains; on heating, it gives out part of its gas, but soon begins to distil over. It dissolves copper, iron, tin, zinc, and bismuth, but neither quick silver, silver, nor gold. When it acts upon black oxide of manganese, chlorine gas is emitted; one sect affirming that the muriatic acid is decomposed, and the hydrogen unites with part of the oxygen of the oxide forming water, and thus the chlorine is set free: while the other sect thinks, that the muriatic acid absorbs an extra charge of oxygen from the oxide, and thus becomes what Berzelius calls the muriatous superoxide, = M^3, which being extremely volatile, flies off in the form of a gas.

Spirit of salt dissolves the red oxide of quick silver, and the solution being evaporated, and crystallized, yields a muriated peroxide of quick silver, exactly similar to corrosive sublimate.

Spirit of salt added to a solution of lead, or of silver, in a nitric acid, unites with the oxides and falls down, being insoluble, as a chloride of silver or lead, on the one theory, or as a muriate of silver or lead, on the other.

The addition of nitric acid to spirit of salt, enables it to dissolve quick silver, gold, and platinum; it is then called aqua regia, or the nitro-muriatic acid; the proportion necessary, is best ascertained by adding one acid to the other, being gently heated on the metal, until the solution begins to take place. Some think, chlorine is formed or disengaged in this mixture, but the real theory is not exactly determined. The salts of gold and of platina, formed by crystallizing these nitro-muriatic acids, are called the muriate of gold or of platina.

This nitro-muriatic solution of gold is used to procure pure gold, by adding a solution of green vitriol in water to it: pure gold is thrown down, which may be treated with a little weak spirit of salt, to separate any admixture of iron.

The muriate of tin being added to the nitro-muriatic solution of gold, a purple powder, called Cassius's purple precipitate, falls down: used as a colour. Some consider it as a combination of the oxides of gold and of tin; others, as a stannate of gold, supposing the oxygenized tin acts as an acid in this combination.

Corrosive Sublimate.—Corrosive sublimate, or bichloride of quick silver, crystallizes in four-sided prisms: it is very hard; specific gravity 5·2; taste acrid, and peculiarly nauseous; soluble in about half its weight of boiling water, and only in 20 times its weight of cold water. Four parts being rubbed with three of quick silver, until the metal is no longer visible, and then exposed to heat, sublime in white four-sided prismatic crystals, which are powdered and washed in a large quantity of water to get rid of any corrosive sublimate, that might have escaped union with the quick silver. This sublimate is called calomel, and is considered by some to be a simple chloride of quick silver, the metal having united with one of the two charges of chlorine, constituting the corrosive sublimate; but others suppose one of the two charges of oxygen, contained in the peroxide constituting the corrosive sublimate, unites with the added metal, and the whole becomes a protoxide, 2 charges of which combine with a single one of muriatic acid, and thus forms a submuriate of protoxide of quick silver, the calomel here produced.

Corrosive sublimate, if ground with filings of tin and exposed to heat, furnishes a liquor, that, on the bottle which contains it being opened, in a moist air, constantly emits visible fumes : this liquor is a bichloride of tin, or a muriate of peroxide of tin, according to the theory that may be espoused.

Corrosive sublimate ground with sulphuret of antimony and heated, furnishes, first, a caustic sublimate, called, from its appearance, butter of antimony, which in a moist air melts into a yellow liquor, called oil of antimony; usually confounded by the retailers with the butter: after which, on increasing the heat, a sulphuret of quick silver sublimes, distinguished by the name of cinnabar of antimony. The butter and oil are, in fact, either a muriate of one of the more highly charged oxides of antimony, or a chloride of that metal: on the addition of water, an oxide of antimony falls down, which is distinguished by the name of Algarotti's powder; by the French, according to their usual negligence in writing foreign names, turned into poudre d' algaroth.

Oxymuriatic Acid.—The oxymuriatic acid gas, or chlorine gas, is of a greenish yellow colour; a gallon weighs about 175 grains; it is very speedily absorbed by about half its bulk of water; its smell is pungent, very disagreeable; if respired, even when largely diluted with atmospheric air, it produces a suffocating cough.

Chlorine gas added to an equal bulk of hydrogen and exposed to the light, is changed into muriatic acid gas, or as Gay-Lussac calls it, hydrochloric gas. The rationalists say, the hydrogen unites with the extra charge of oxygen in the oxymuriatic acid gas, and forms water, which is retained by the muriatic acid, and constitutes about one fourth of its weight, that is to say, $M^3 + H$ forms $M^2 H^1$; the Epicurean school say, the chlorine and hydrogen unite together into a binary compound, which they call the hydrochloric gas; that is to say, $C + H$ forms $C H$. Light is somehow necessary to this operation, which takes place rapidly in the rays of the sun, or when an electric spark is passed through the mixed gases, and but slowly in the contrary case: and Seebeck has found, that blue light occasions a quicker union of these gases than orange light.

Iron wire, heated in oxymuriatic acid gas, or chlorine gas, burns with a red light, and beautiful brown scales are formed, which dissolve in water, and form an oxymuriate of iron.

100 grains of sulphur, absorb 300 cubic inches, or more than 10 pints, of chlorine gas, and a yellow liquid is formed, called chloride of sulphur, which emits suffocating fumes when exposed to the air; it does not affect vegetable blues; but on adding water, sulphuric, sulphurous, and muriatic acids are formed.

White Arsenic.—White arsenic is obtained principally in Saxony, from cobalt ore, by heating it in a reverberatory furnace, with a flue carried horizontally to a good distance; the white arsenic settles on the sides of this flue in a solid crystalline mass. Every two years the flue is opened, and the sublimate is struck off in great lumps, by a chisel: the Pharmacopœia orders it, for medical use, to be resublimed, but plenty of very pure transparent crystals may be picked out of that in the shops: by degrees it becomes opaque. White arsenic is by some considered as an oxide, by others, as an acid, which they call the arsenious acid. Fortunately, it requires about 400 times its weight of cold water to dissolve it, or 13 of boiling water. The taste is sweet but acrid; it is tonic, in doses of from a tenth of a grain to a fourth, in pills; or, dissolved in water, 1 gr. to an ounce, and a tea spoonfull taken daily, used in intermittent fevers; and is thus of immense use in medicine, when the Peruvian bark cannot be obtained, or rapid movements prevent a sufficient supply of that article to be carried with the troops: a larger dose produces inflammation and gangrene of the stomach. If a person is suspected to be poisoned with arsenic, the antidote that is most readily obtained, is a solution of soap; and the contents of the stomach may, to obtain satisfaction, be dissolved in boiling distilled water, the solution strained, and then, if any white arsenic has been taken up, on the surface being touched with a stick of lunar caustic, a sulphur yellow precipitate will fall down immediately from the place touched.

White arsenic, heated with charcoal dust and nitre fixed by charcoal, yields a sublimate, erroneously called regulus, of metallic arsenic; the potasse unites with the white arsenic, and the arsenite of potasse being less volatile than the white arsenic itself, the heat has power to act on the mixture when the charcoal absorbs the oxygen from the white arsenic, and forming carbonic acid gas escapes and leaves the metal pure.

On the other hand, 2 parts, by weight, of white arsenic, distilled with 6 of nitric acid and 1 of muriatic acid, yield arsenic acid, in which an additional charge or two of oxygen is taken from the nitric acid and transferred to the white arsenic; but the quantity of oxygen in white arsenic, or in arsenic acid, is variously stated by authors, and is not yet properly determined.

Borax.—Borax is obtained from the lakes of Thibet, where the rough borax, called tincal, crystallizes in the shallows; this impure borax is afterwards refined, either in India or Europe. Borax is a combination of boracic acid with soda, but its exact composition is not known; however, it requires half its weight more acid to render it neutral, hence its taste is alkaline. It is soluble in 20 times its weight of cold water, and 6 of boiling water. On being heated, borax puffs up, becomes white, and afterwards melts into a clear glass-like mass, called glass of borax. Borax is sometimes used internally as an emmenagogue, but more frequently externally, as a gargle or lotion in aphthæ of the mouth, or in excessive salivation.

Borax being dissolved in water, a little sulphuric acid dropped into the solution, unites with the soda, forming sulphate of soda, which remains united with the water, and the boracic acid is set free in small shining crystals, which are to be washed with a little cold water. To obtain the whole of the boracic acid, the remaining solution is to be evaporated, and laid aside to cool, when a fresh crop of crystals of the acid will be obtained. Boracic acid was formerly used as a sedative, under the name of sedative salt of vitriol.

White Sand.—White sand, well washed, is the most common or only form of silica used in pharmacy. Not being acted upon by acids, it is employed to filter them, some broken pieces of glass being put in the throat of a funnel to support the sand.

Fluor Spar.—Fluor spar, of which a very common variety is called blue John, by the miners, is found plentifully in Derbyshire, and hence also named Derbyshire spar. It is generally esteemed a combination of fluoric acid with lime, or a fluate of lime, although some conceive it to be the metallic basis of quick lime, called calcium, united with the hitherto unseparated principle they call fluorine, which last they suppose forms fluoric acid by uniting with hydrogen.

Powdered fluor spar, having oil of vitriol poured upon it and exposed to heat, emits the fluoric acid in fumes that corrode glass, and must therefore be collected by using leaden or silver vessels. This acid is excessively corrosive; the least drop falling on the skin produces great pain and an ulcer that heals with much difficulty. Some think the sulphuric acid simply unites with the lime of the fluor spar, and forming a sulphate of lime, while fluoric acid, thus set free, escapes by its volatility; others conceive the water in the sulphuric acid is decomposed, its oxygen uniting with the calcium of the fluor spar, which they consider as a fluoride of that metal, and forming the lime that unites with the sulphuric acid; while the detached fluorine unites with the hydrogen of the decomposed water, and forms the fluoric acid that escapes.

Lime Stone.—Lime stone is distinguished from other stones by its effervescing when either sulphuric, nitric, or muriatic acid, is dropped upon it: for, being a carbonate of lime, composed of about 43 parts, by weight, of carbonic acid, united with 57 of lime, these acids uniting with the lime, expel the carbonic acid in the form of gas, thus causing a froth. On exposure of lime stone to a long continued red heat, the carbonic acid is also expelled, and the lime is left in a state of quick lime, which grows hot when water is poured upon it; as may be tried with a small piece placed in the palm of the hand, and a few drops of water poured on it. The quick lime combines with a portion of water, and constitutes slaked lime, or hydrate of lime, in the artificial language of the chemical schools. Lime stone is used in the Pharmacopœia to ascertain the proper strength of the nitric and muriatic acids for medical use, in a manner more convenient to apothecaries than by their specific gravity; an ounce measure of nitric acid, being diluted with water, should dissolve seven drams Troy of lime stone; and the same measure of muriatic acid, also diluted, should dissolve three drams and two scruples of that stone. This method cannot be applied to oil of vitriol, as the sulphate of lime is scarcely soluble in water.

Chalk.—Chalk is of the same nature as lime stone, but softer; the lime from it is distinguished by the name of chalk lime, as the other is sometimes called stone lime. The

College have also ordered a shell lime, to be made from oyster shells by burning; but all are alike. The latter, or shell lime, is common in countries where no native carbonate of lime can be obtained, but not used in the neighbourhood of London, as that town stands on a bed of chalk. For medical purposes, chalk is ground and diffused through water; after a few minutes' rest the white liquor is poured off and left to settle, by which a finer and more uniform powder is obtained than by the pestle and mortar, and the water carries off any soluble matter that may be accidentally present. All solid substances, insoluble in water, which are reduced to powder and washed over in this manner, are in pharmacy called prepared articles. Prepared chalk is used as an absorbent and antacid, in diarrhœa and dysentery, generally from ℈j to ʒj, sometimes to ʒij.

Chalk being mixed and heated with an equal weight of charcoal dust, yields a gas that weighs about 68 grains per gallon, and which, when a stream is set alight, burns with a blue weak flame, without depositing any moisture. This is called carbonic oxide, and is considered as the unoxide, or C^{1}. In this experiment, the charcoal abstracts one charge of oxygen from the carbonic acid, as it is disengaged from the lime, and thus both the charcoal and carbonic acid are changed into this gas.

Chalk, or, which is still better as being more slowly dissolved, the harder kind of lime stone, as they dissolve in diluted spirit of salt, give out their carbonic acid in the form of gas, which was formerly called fixed air, the muriatic acid uniting with the lime.

Quick Lime.—Quick, or rather slaked lime, is slightly soluble in water. This lime water is speedily altered by exposure to the open air, from which the lime abstracts the carbonic acid gas, and being thus restored to its state of a carbonate of lime, is rendered insoluble and forms a crystalline skin on the surface. To keep, therefore, the water in a saturated state, it is usual to add a much larger quantity than the water can dissolve, which is only about 10 grains in the pint; so that when the admission of the atmospheric air, by the necessary opening of the bottle, separates a portion of the lime from the water, another may be taken up from the superabundant slaked lime, at the bottom of the bottle.

Slaked lime being mixed with one third of red oxide of quick silver, moistened with water and made into a cup, into whose cavity a dram of quick silver was put, and then connected with the two ends of a galvanic apparatus, the positive wire touching the platina dish, on which the cup was placed, and the negative wire the quick silver in the cup, the quick silver was converted into an amalgam, which being distilled in a glass tube filled with the vapour of naphtha, the quick silver distilled over, and the metallic basis of the lime, called calcium, was left in the tube. This calcium is white like silver, and on exposure to air absorbs oxygen from it, and is reduced again to lime, which thus appears to consist of 2·625 of calcium, united with 1 of oxygen.

Lime Water.—Lime water, or liquor calcis, as the College calls it, is employed as an astringent and antacid, from a gill to a pint daily, in divided doses; either by itself, or with milk to take off its unpleasant flavour; it has also been considered of considerable benefit in calculous complaints.

Hot lime water converts calomel into the gray oxide or protoxide of quick silver; the Pharmacopœia orders a gallon of lime water to be boiled on each ounce of calomel. Like most cases in which muriatic acid is concerned, this is explained in two ways: in the first, there is only a simple transfer of the muriatic acid from the oxide of quick silver in the calomel to the lime, whence the products are, gray oxide of quick silver, and a solution of muriate of lime; in the other theory, the chlorine of the calomel unites with calcium of the lime into a soluble chloride, and the quick silver unites with the oxygen of the lime into a protoxide. Gray oxide of quick silver is used as an alterative and deobstruent, gr. ij to gr. x; or externally, to irritable syphilitic sores, and as a fumigating powder.

A vessel containing lime water, and another of oil of vitriol, being placed in a receiver, and the air exhausted by an air pump, the oil of vitriol gradually absorbs the water in the other vessel, and the lime separates in imperfect six-sided crystals.

Carbonic Acid Gas.—Carbonic acid gas, or fixed air, as it was called, weighs about 108 grains per gallon, and may be poured out of one vessel into another; an operation which is rendered visible by blowing out a wax taper and letting the smoke mix with this gas. In consequence also of this density, it remains in an open vessel for some time before it mixes with the atmosphere; and is often accumulated in wells and cisterns, where, as it is not respirable, it drowns persons who incautiously venture into them, without first letting down a candle to try whether the air will maintain the flame, in which case it will also serve for the respiration of mankind. If the candle is extinguished, several pails of water may be flung down partly to absorb the carbonic acid gas, and partly to produce a motion that may cause its diffusion throughout the atmosphere.

Carbonic acid gas is absorbed at the common pressure of the atmosphere, by an equal bulk of water; on increasing the pressure more is taken up. The liquid carbonic acid thus formed, soon loses its acid by volatilization; and that which has been formed by applying pressure, froths on the pressure being taken off, and the superfluous acid gas escapes with more or less violence. This surcharged liquid carbonic acid has been used medicinally, under the name of aërated water, or water impregnated with fixed air, as a gentle stimulus to the stomach, and an antiscorbutic. Several different apparatus for making it have been proposed; Dr. Nooth's is well suited for medical purposes.

Pearl Ash.——Pearl ash is generally imported from America or Russia, where timber trees being regarded as weeds, are burned for common fewel, and used in the most careless manner for building and fences: the roots are burned for their ashes. These ashes being put into tubs or cisterns, have water repeatedly run through them, until it has taken from them a sufficient quantity of salt to be boiled down nearly to dryness, in iron pots. The first salt thus obtained is then calcined in a kiln, with access of air to burn away the oily or carbonaceous matter that renders it dark coloured; and being again dissolved in water, the solution is boiled down until it begins to dry on the edges of the liquid, when the fire being removed, it is stirred until cold to give it the granular appearance, from whence it is termed pearl ash. It still contains sulphate of potasse, and muriate of potasse, and a little glass or silica, to get rid of which, it is dissolved in once and an half, or at most twice its weight of water, and the solution being filtered, is boiled down as before. By these means, an alkaline salt is obtained, usually called salt of tartar, as being very frequently procured from argol or the tartar of wine casks, and sometimes salt of wormwood, as having been frequently made by apothecaries from that herb. This salt is a nearly pure carbonate of potasse, although called in the London Pharmacopœia the subcarbonate, as though its composition were $C^2 + 2 P^2$, instead of $C^2 + P^2$. It is used as an absorbent or antacid, in doses of gr. v to ℈j; it has also been employed as a cathartic, to ʒj, or even more.

Salt of Tartar.—Salt of tartar attracts the water from the atmosphere, and melts into a clear water, called oil of tartar. The College orders it, under the name of liquor potassæ subcarbonatis, to be made by dissolving each oz. Troy of the carbonate in an oz. measure of distilled water.

Salt of tartar effervesces and lets go the carbonic acid on the addition of sulphuric acid, forming vitriolated tartar, a sulphate of potasse, similar to the sal enixum obtained in distilling salt petre with green vitriol for aqua fortis. A salt of the same kind is ordered in the Pharmacopœia, by neutralizing the supersulphas potassæ by the addition of salt of tartar. The sulphate of potasse is very hard, and but slightly soluble in water.

Salt of tartar, melted with an equal weight of sand, converts it into glass; but with only a fourth part a compound is formed, soluble in water: the solution is called liquor of flints, as flints powdered by being heated red hot, and then flung into water to crack, were usually employed instead of sand. This silicate of potasse is used as a test liquor.

Salt of tartar, heated with an equal weight of luna cornea, obtained by precipitating the nitric solution of silver by common salt, is the best method of obtaining a regulus of pure silver.

Salt of tartar, mixed with an equal measure of charcoal dust, is a good reducing flux for melting any ores previously roasted, to ascertain what they would yield when smelted in the ordinary method. This mixture is called, from its colour, the black flux, as salt of tartar alone is, when thus used, called the white flux.

This black flux and sulphuret of antimony, melted together, yield a regulus of antimony; while the potasse of the carbonate unites with the sulphur of the sulphuret, and some of the metallic antimony, thus forming a triple compound, which, on being dissolved in 20 times its weight of water, filtered, and a little acid, either the sulphuric or muriatic, as may be at hand, dropped into it to saturate the potasse, lets fall the golden sulphur of antimony, Here the water is supposed to be decomposed, its oxygen uniting with the antimony metal and forming an oxide, while the hydrogen of the water unites with the sulphur and forms a hydrosulphuret, which unites with the oxide just formed, but is kept dissolved by the potasse: the acid that is added combining, in preference, to the alkali, the hydrosulphuretted oxide of antimony, or golden sulphur, is precipitated.

A solution of salt of tartar curdles several solutions of metals in the various acids: as iron or nickel in sulphuric acid, or lead or cobalt in nitric acid; the two acids exchanging their bases, and hence the precipitates obtained, are the carbonates of the various metals. Sometimes the metals are retained, at least partly, in the supernatant liquor, as in the liquor ferri alkalini of the Pharmacopœia, made by dissolving iron ʒijſs in 2 oz. meas. of nitric acid, diluted with 6 oz. meas. of water: as soon as the solution ceases, the liquor is poured off, and 6 oz. meas. of oil of tartar are gradually added; after resting for 6 hours, the clear liquor is poured off for use; here a potasse nitrate of iron is formed.

Four parts of oil of vitriol being boiled on one of regulus of antimony to dryness, and the residuum washed with a solution of salt of tartar, in a large quantity of water, the protoxide of antimony is obtained.

A solution of salt of tartar boiled upon sulphuret of antimony, the solution strained while hot and let to stand till cold, deposits a dark red powder, called kermes mineral, much used on the Continent in fevers, as a diaphoretic. The theory is the same as that of the golden sulphur of antimony, but the kermes probably contains more oxide of antimony and less sulphur than the golden sulphur.

A pound of salt of tartar being dissolved in two pints of boiling water, and half a lb. of lime slaked with 6 pints of boiling water, the liquors mixed while hot, and strained through cotton, is the liquor potassæ of the Pharmacopœia, commonly called soap ley. It ought not to effervesce when an acid is dropped into some of it, and a pint ought to weigh 16 Troy ounces. When evaporated to dryness, it is called, in the Pharmacopœia, potassa fusa, being the hydrate of potasse of the chemists, and the stronger common caustic of the surgeons, which is but little employed, as it spreads very much; to hinder which, and also to weaken its action, a lb. of fresh slaked lime is ordered to be added to 3 pints of the liquor potassæ, boiled down to a pint. In this operation, the lime absorbs the carbonic acid from the potasse.

Salt of tartar, rubbed with half its weight of sulphur and melted together, is the sulphuret of potasse, usually called liver of sulphur, ordered by the London College; used in small doses, as an alterative and diaphoretic, in eruptive diseases; also externally, as a lotion, ʒj, to lb. j of common or lime water. Berzelius has shown, that sulphur and potasse combine in many various proportions; and that when salt of tartar is melted with sulphur, one quarter of the potasse forms sulphate of potasse, and the other three form sulphuret of potassium.

Potassa fusa.—Potassa fusa being placed in the breech end of a gun barrel, so bent that the middle, filled with iron turnings and coated with clay, may be strongly heated, and the potasse, when melted by a chafing dish, may run slowly down among the turnings: to the mouth of the bent gun barrel is to be fitted, by grinding to the muzzle, a copper tube and small receiver with a glass tube, whose further extremity is sunk under some quick silver in a basin. On the melted potasse touching the heated iron, the water contained in it loses its hydrogen, which escapes; the oxygen of the water and of the potasse unites with the iron, forming a protoxide of that metal, and the potassium being thus set free is volatilized and collected in the copper tube and receiver, which must be kept cool by the application of wet cloths. To prevent accidents, by the potassium blocking up the copper tube, one end of a tube is inserted in the breech end of the barrel, the other extremity of which is sunk in a deep jar of quick silver. If, then, during the operation, gas is observed to issue through this tube, some live charcoal must be applied to the muzzle of the barrel and the copper tube, until the gas issues at the basin. The potassium, when collected, must be kept under the fine mineral oil called naphtha, to prevent the access of the air to it.

Potasse water curdles the solutions of several metals in acids, the alkali uniting with the acid and letting go the oxide, which falls down; some of these are mere oxides: in other cases, as in the precipitation of the nitric solution of copper, the oxide unites with some of the water, and forms a hydrated oxide of copper. Thus 1000 gr. of diluted sulphuric acid were found to require 10148 gr. of aqua kali puri of the London Pharmacopœia, ed. 1788, for their saturation; and there was produced 978 gr. of sulphate of potasse. The same weight of acid dissolved 164 gr. of zinc, emitting 9 gr. of hydrogen: the above weight of potasse water being added, threw down 220 gr. of oxide, and by evaporation, 976·5 gr. of sulphate of potasse were obtained: as the zinc had increased 56 gr. instead of 20·5, the oxide probably contained 35·5 of water. Sometimes the potasse unites not only with the acid, but also with the oxide: thus, on adding potasse water to muriate of platina, precipitation takes place, and a potasse-muriate of platina is formed, that is scarcely soluble.

If potasse water is exposed to a current of chlorine or oxymuriatic acid gas, two salts are formed: the one is muriate of potasse crystallizing in cubes; the other, which crystallizes in shining flat plates, is the oxymuriate of potasse, called by some the chlorate of potasse. The acid in this latter salt is considered as a quintoxide of chlorine by some, and as a sexoxide of muriaticum by others.

Potassium.—Potassium is silver white of very great metallic lustre, instantly tarnishing when exposed to the atmosphere; at 32° Fahr. it is hard and brittle; at 60° it is soft like wax, and malleable; it melts at 150° Fahr. and burns in the open air with a brilliant white flame.

The specific gravity of potassium is only 0·85, so that it swims upon water; where it takes fire, hydrogen gas is evolved, and the oxygen of the water unites with the potassium, forming potasse which dissolves in the water.

Potassium absorbs nearly an equal weight of chlorine gas, and forms a white salt, called muriate of potasse, or chloride of potassium.

Potassium heated in muriatic acid gas, forms the same salt, and hydrogen gas is left.

In consequence of this strong attraction of potassium for oxygen, it is employed in many experiments to separate oxygen from several combinations: thus boracic acid, heated with potassium, yields its oxygen to the latter; the potasse thus formed may be washed out with water, and thus the base of the boracic acid, or boron, is left, which appears like a brown insipid powder, not altered by exposure to air, but when heated, it burns with great brilliancy, and boracic acid is reproduced.

Potassium also heated even in carbonic acid gas, absorbs the oxygen, and charcoal is deposited.

Potassium unites with hydrogen gas, and also with sulphur, by being heated with them.

Liver of Sulphur.—Liver of sulphur dissolved in water, yields a yellow solution. On adding either sulphuric or muriatic acid to this solution, a very fetid gas is emitted, called hepatic gas or supersulphuretted hydrogen, which gives their peculiar smell to what are called stinking spaws, such as those of Harrowgate, or Aix la Chapelle. The theories of these changes are very complicated, and have not been satisfactorily explained. Some consider liver of sulphur as a sulphuret of potasse, and think that on water being added, its oxygen and hydrogen unite with the sulphur, and sulphuric and sulphurous acids are formed with the one, and sulphuretted hydrogen with the other; others think the liver is a sulphuret of potassium, in which case, the hydrogen of the water unites with the sulphur, and the oxygen with the potassium.

Oxymuriate of Potasse.—Oxymuriate of potasse, as it is most usually called, on being heated, yields about a cubic inch of oxygen by the grain, so that half an ounce will yield a gallon.

A few gr. of oxymuriate of potasse having thrice its weight of sulphuric acid added to it, and being gently heated, yields a yellowish green gas, which must be collected in jars, standing in a quick-silver trough. This gas is called euchlorine or deutoxide of chlorine; it is of an aromatic odour, and is absorbed by a seventh part of its volume of water, forming a yellowish astringent liquid. This gas being heated to 212° Fahr. explodes, emits much light, increases its bulk by one half, and is changed into a mixture of two volumes of oxygen with one of chlorine. Berzelius considers this gas as a tetroxide of muriaticum, and calls it muriatic superoxide; and others, as a combination of chlorine with three charges of oxygen.

Oxymuriate of potasse moistened with three times its weight of sulphuric acid, and heated till it becomes white, is changed into a mixture of bisulphate of potasse and oxychlorate of potasse; the former salt being more soluble than the oxychlorate, may be washed away with cold water. On heating this oxychlorate to 412° Fahr. oxygen gas is given out, and it is changed into common salt. When this oxychlorate is distilled with its own weight of sulphuric acid, in a heat a little above that of boiling water, an acid liquor passes over, called oxychloric or perchloric acid, which is considered by some as a heptoxide of chlorine, and by Berzelius, who calls it oxymuriatic acid, as an octoxide of muriaticum.

Oxymuriate of potasse, having dilute muriatic acid poured upon it, and a gentle heat applied, emits, slowly, a yellowish green gas, darker than the deutoxide of chlorine; whose smell resembles that of burnt sugar. It explodes feebly, by a very gentle heat, sometimes even by that of the warm hand; its bulk is increased by one fifth, and it is changed into a mixture of two volumes of chlorine and one of oxygen; whence it is looked upon by some as a protoxide of chlorine, but others consider it as a variable mixture of chlorine gas and euchlorine.

Oxymuriate of potasse mixed with sulphur, causes the sulphur to take fire on being touched by oil of vitriol: this is the essential part of the composition of the matches for instantaneous light.

Chlorine, or oxymuriatic acid, gas, passed through water, having oxide of silver diffused through it, is absorbed; chloride of silver, or muriate of oxide of silver, is formed, which may be separated by the filter; on heating the liquid that passes the excess of chlorine is volatilized, and chloric acid is left. This chloric acid does not form a precipitate with any metallic solution.

Platina, digested in nitromuriatic acid, is mostly dissolved; the black residuum being fused with potasse, and digested in water, yields a yellow solution. On saturating this yellow solution with sulphuric acid and distilling it, the liquor that passes over has a sweetish taste, a smell of new bread, and when quick silver is shaken in it, an amalgam is formed, which on distillation leaves the new metal, osmium, behind.

Osmium is dark gray; insoluble in acids, soluble in potasse; easily oxided: the oxide is very volatile, and smells like new bread.

The powder remaining after the above yellow solution has been decanted off, digested in muriatic acid, colours it first blue, then olive green, and lastly red. When no more is taken up, it may be fused with fresh potasse, which will enable the muriatic acid to dissolve a fresh portion. If a plate of zinc is put into this muriatic solution, the new metal, called iridium, will be precipitated; or it may be obtained by evaporating the solution to dryness, and violently heating the residuum.

Iridium is whitish, and extremely difficult either to melt or to dissolve in the acids: its specific gravity is above 18.

Epsom Salt.—Epsom salt was originally obtained by the evaporation of the purging water yielded by certain springs at Epsom, 18 miles SW. of London. It is now obtained from sea water, each pint of which contains about 15 grains of this salt; the common salt is previously separated by boiling and straining, and the residual liquor being let into pits, crystallizes at a certain degree of coldness. Epsom salt is bitter, soluble in its own weight of cold water. It is a sulphate of magnesia, containing about half its weight of water of crystallization. It is in very common use as a cathartic, being less disagreeable than Glauber's salt, and a smaller dose, if plenty of diluent liquor be taken, having equal effect. As sulphate of magnesia is very soluble in water, and sulphate of lime scarcely soluble, the dissolving magnesia in dilute sulphuric acid, is a good means to discover any adulteration of it with chalk.

Epsom salt dissolved in three times its weight of water, and three quarters its weight of salt of tartar dissolved in about seven times its weight of water, being mixed together, a white precipitate is thrown down, which being well washed, is called magnesia alba, and is used as an antacid, in doses of ℈j to ʒj, which also prove laxative; and it is an useful addition to draughts of Epsom salt. It mixes better with milk than with water. In this process, the potasse of the carbonate unites with the sulphuric acid of the Epsom salt and forms sulphate of potasse, which is separated by the washing; while the carbonic acid, separated from the potasse, unites with the magnesia of the Epsom salt, and forms carbonate of magnesia, which precipitates.

Magnesia alba.—On exposing carbonate of magnesia to a considerable heat, the carbonic acid flies off, and the magnesia is left. This burnt, or calcined magnesia, is also employed as an antacid laxative; but in general, does not agree so well as the carbonate. Magnesia usta is scarcely soluble in water; it does not absorb moisture or carbonic acid, and may therefore be kept in open vessels; it should not effervesce with dilute sulphuric acid.

Barilha.—Barilha, called in the London Pharmacopœia soda impura, is imported from Spain, where it is obtained by burning the salsola soda, which is cultivated there in the salt marshes for its ash; of which it affords about one fifth of its weight. The ash, or barilha, contains about 22 per cent. of common salt, 14 of carbonate of soda, 40 of subcarbonate of magnesia, 20 of sand and oxide of iron, and 4 of moisture. The ashes of the algæ growing upon our shores, called kelp, do not contain more than 5 per cent. of carbonate of soda.

Barilha dissolved in about four times its weight of water, the solution filtered, evaporated to less than an half, skimming off any crystals of common salt that may form on the surface, and left to cool, yields crystals of carbonate of soda, retaining more than half their weight of water, which it loses by exposure to air, thus becoming dry and powdery; these crystals, in the Pharmacopœia, are called the subcarbonate of soda, and are used as an antacid and attenuant: but it grows powdery, by exposure to the air, from the loss of its water.

Carbonate of Soda.—Carbonate of soda, exposed to heat, melts by degrees, parts with its superfluous water, and forms the sodæ subcarbonas exsiccata of the Pharmacopœia; which is twice as strong as the crystallized, but more convenient, as it does not undergo any further alteration in the air.

A solution of carbonate of soda is used to precipitate the solution of green vitriol; the precipitate thus obtained, being well washed, and dried between folds of blotting paper to prevent the access of air, is the ferri subcarbonas of the Pharmacopœia. It should be of a chocolate-brown colour; but it so rapidly absorbs oxygen from the air, when moist, that it is seldom prepared: it is, however, supposed to sit easier upon the stomach than the red oxide. In this process, the sulphuric and carbonic acids change places, the sulphuric acid uniting with the soda and being washed away, while the carbonic acid unites with the protoxide of iron.

Carbonate of soda mixed with quick lime, elixated with water, and strained, forms hard soap lees, and this being boiled down, gives the hydrate of soda; from whence sodium may be obtained, in the same manner as potassium from potasse.

Sodium resembles lead, in colour; when thrown upon water it swims thereon, being one tenth lighter; hydrogen is rapidly evolved but not inflamed, and a solution of soda is obtained.

When a solution of some kinds of kelp, particularly of the French, is evaporated to a pellicle, let to cool, and the crystals separated, the mother liquor, mixed with sulphuric acid, boiled for some time, then as much black oxide of manganesium as there was sulphuric acid being added, and the whole distilled, violet colour vapours will ascend and form opaque metallike crystals, called iodine. The waste ley of the soap makers may be employed, when it can be procured.

Iodine.—Iodine, or hyperoxide of iodium, is blueish black, soft, friable, very nearly 5 times as heavy as water; it stains the skin yellow; taste extremely acrid; by a slight heat, it rises in violet colour vapour; when separated by galvanic action, it is determined like oxygen the oxides and acids to the zinc end of the apparatus. Some suppose iodine to be a principle analogous to oxygen or chlorine; others esteem it a hyperoxide of a metal, which like muriaticum, or nitricum, can only be separated from its alloys, by means in which it is necessarily united with oxygen. Iodine, gr. vj, produces violent vomiting.

Iodine unites with zinc and forms volatile crystals, which deliquesce, and are called either the hydroiodate, or iodate of zinc.

Iodine melts with iron, and forms a red oxide, which is reduced by water to a hydroiodate, or iodate of iron.

Similar effects take place on uniting iodine with other metals, as lead; as also with sulphur; quick silver, merely shaken with iodine, forms a beautiful red powder; but charcoal and iodine have no effect on each other.

Iodine added to liquor of potasse, is partly changed into a superoxiodate of potassium, which falls down, and partly into iodate of potasse; which last may be crystallized. It has been proposed as a remedy in bronchocele.

Iodine exposed to chlorine gas, forms deep orange crystals, which are fusible, and run in the air, into a sour liquid called by some, chloriodic acid; for they suppose it to be an acid composed of chlorine and iodine, as muriatic acid is to them an acid formed of chlorine and hydrogen; others think that part of the oxygen of the chlorine is transferred to the hyperoxide of iodium, and a compound acid of hyperoxiodic and muriatic acids is formed.

Iodine exposed to euchlorine gas, forms a compound, from which chloriodic acid is separated by a gentle heat, and a white, scentless, semitransparent, sour substance is left, which is very soluble in water, and is called by some, oxiodic acid. Here the iodine is supposed to unite partly with the chlorine, and partly with the oxygen of the euchlorine; but others explain this, on similar principles to the former.

If iodine is diffused in water, and a current of sulphuretted hydrogen passed through it, the hydrogen abstracts part of the oxygen from the iodine and converts it into iodic acid.

Moist iodine added to phosphorus, yields a sour colourless gas, which is rapidly absorbed by water, and must be collected in a quick-silver apparatus; a gallon of this gas weighs about 311 grains. Here the changes are either $I^3 + P$ into $I^2 + P^1$, or $I + P + H^1$ into $I H + P^1$; and the new acid is called the iodic or hydroiodic. Water, which has absorbed this gas, may be concentrated by distillation, until its specific gravity is 1·7, or nearly that of oil of vitriol. This iodic, or hydroiodic acid, becomes dark coloured when kept, as iodine is formed, which dissolves in the acid.

Iodic acid gas mixed with chlorine gas, is instantly changed; muriatic acid is formed, and violet vapours of iodine appear; light is frequently emitted. This is explanable either by saying $I^2 + M^3$ forms $M^2 + I^3$, or $H I + C$ forms $C H + I$.

Iodic acid being poured into several solutions of metals in acids, the iodine unites with the oxides, and iodides of the several metals are precipitated.

Iodic acid and potasse or soda, form iodates either of potasse or soda.

Sulphate of Strontia.—A stone, having the specific gravity of 3·2, is found at Strontian, Argyleshire, in Scotland, and also near Bristol, in England, which appears to be a sulphate of strontia.

Sulphate of strontia being mixed with charcoal dust and heated, the carbone abstracts oxygen from the sulphuric acid and flies off as carbonic acid gas; the sulphur thus left combines with the strontia, and forms a sulphuret, which being dissolved in water, the solution strained, nitric acid added gradually to separate the sulphur, then strained again and crystallized, yields nitrate of strontia. By exposure to heat, the nitric acid is driven off, and strontia, or the oxide of strontium, only is left; which when exposed, in contact with quick silver, to the action of the copper end of a galvanic apparatus, is reduced to an amalgam, from whence the quick silver may be expelled by heat, and strontium left, of a dark gray colour, more than twice as heavy as water.

Cawk, or heavy Spar.—Cawk, or heavy spar, is a very common stone, distinguished by its great specific gravity, 4·7. It has been sold and used by the apothecaries as lapis calaminaris. Some varieties, when heated to redness, acquire the property of absorbing light from the rays of the sun, and emitting it again when carried into a dark place. It contains 66·1 per cent. of barytes, and 33·9 of sulphuric acid, and is one of the most insoluble of the improper salts, as it requires 43000 times its weight of water to dissolve it.

Sulphate of barytes mixed with charcoal dust and exposed to a red heat for some hours, is converted into sulphuret of barytes; the charcoal carrying off the oxygen of the sulphuric acid in the form of carbonic acid gas.

From this sulphuret of barytes, previously dissolved in water, the nitrate may be prepared by nitric acid, as in preparing nitrate of strontia; or the muriate, by adding muriatic acid, straining, and crystallizing the liquid. The crystallized muriate of barytes, or chloride of barium, as it is also called, dissolved in three times its weight of water, has been used, in very small doses, in cancer and scrofula.

Nitrate of barytes, by exposure to heat, leaves barytes, or oxide of barium, which is grayish white, and absorbs water, thus forming a hydrate, which is soluble in water.

Barytes.—Barytes heated in oxygen gas, absorbs a portion of it, and becomes a peroxide of barium: this being dissolved in dilute muriatic acid, the extra charge of oxygen unites with the water. The barytes may be separated by adding sulphuric acid, and the muriatic acid, afterwards, by the addition of sulphate of silver; luna cornea being precipitated. The sulphuric acid may then be removed in its turn, by means of barytes, when nothing will remain but a mixture of water and deutoxide of hydrogen. By placing a vessel of this mixture in the exhausted receiver of an air pump, along with a plate of oil of vitriol, to absorb the aqueous vapour as fast as it is formed, the deutoxide will be obtained pure, 1·453 times as heavy as water, and containing just twice as much oxygen in proportion to hydrogen as water. This deutoxide acts considerably on the skin; with oxide of silver it produces an explosion, and most other oxides and metals expel the second charge of oxygen, with more or less violence.

Barytes exposed to galvanic action, in contact with quick silver, forms an amalgam, from whence the quick silver being driven by heat, a metal of a dark gray colour is left, called barium ; but lately the name of plutonium has been proposed.

Bone Ashes.—Bone ashes are received as an article of the materia chemica, as the most economical source from whence phosphoric acid may be extracted. Those usually employed, are first collected for the makers of cart grease, who cleanse, grind, and boil them, to extract the grease; they are afterwards distilled for hartshorn and ivory black, or bone ash ; if the latter is required, the iron still being opened while red hot, the black residuum is stirred so as to expose every part to the air, until the ivory black is burnt to whiteness : bone ash thus prepared is a phosphate of lime. The College order a variety of this, by the name of cornu ustum, burnt hartshorn, to be made from harts horn burnt to whiteness, which is employed as a weak absorbent. The foreign assayers prepare also, from fish bones, a fine kind of bone ash, which they use for making cupels. The colour shops use the ashes of mutton bones for crayons and ground for pictures.

20 lb. of bone ashes diffused through 40 lb. of water, and having a mixture of 8 lb. of oil of vitriol, with as much water added, is to be simmered together for several hours, strained, water poured upon what is left on the strainer, until it passes through without becoming sour, and the whole liquor evaporated to one half, then left to cool, decanted from the sediment that settles, and again evaporated to dryness : thus phosphoric acid is obtained, by the sulphuric acid uniting with the lime, and the sulphate of lime is left, partly on the strainer, and partly in the sediment formed during the evaporation. Or, if to the strained liquor, a sufficient quantity of carbonate of soda is added to saturate it, and the liquor is crystallized, phosphate of soda is obtained ; which was attempted to be brought into use as a tasteless purging salt, but unless the patient is used to take much salt in his broth, this name is by no means applicable.

Phosphoric acid mixed with charcoal dust, and distilled into water, yields much carbonic acid gas, and a wax-like substance, called phosphorus, which is rendered purer by keeping melted for some time, in glass tubes, closed at one end by corks, under warm water ; when the impurities have settled, it is let to cool slowly, after which, taking out the corks, the sticks of phosphorus may be pushed out, and the clean part cut off.

Phosphorus.—Phosphorus, in the open air, is luminous, and exhales a smell of garlick; if the air is moist, it is converted into a mixture of phosphorus and phosphoric acid. A very slight heat sets it on fire, so that it must always be kept and managed under water; the burns it produces are very painful: it has been used in medicine as a stimulant, in very small doses.

Phosphorus dried by blotting paper, introduced into a bent assay tube of atmospheric air, and gently heated, absorbs all the oxygen, leaving the azote, thus forming one of the simplest and most perfect eudiometers.

Phosphorus burns also in oxymuriatic or chlorine gas, and each grain absorbs 8 cubic inches, forming a white, fusible, crystallizable, and volatile substance, being either a phospho-muriatic acid or bichloride of phosphorus, according to the different theories of muriatic acid. On adding water, muriatic acid and phosphoric acid are formed; $(P\ M)^4$ forming $P^2 + M^2$, or $(2\ C + P) + 2\ H^1$ forming $2\ (C\ H) + P^2$.

Phosphorus distilled with corrosive sublimate, yields calomel and a reddish liquor, called the chloride of phosphorus, but which may also be considered as a phospho-muriatous acid; which is resolved by water into phosphorous acid and muriatic acid, the oxygen being divided among the two bases of those acids, instead of forming a ternary compound.

Phosphorus passed through a tube filled with lime strongly heated, forms a brown phosphuret of lime; on this phosphuret being flung into water, hydrogen gas impregnated with phosphorus, is emitted, which takes fire nearly as soon as it escapes from the surface of the water into the air; and a hydrophosphuret and hypophosphate of lime are formed at the same time.

Phosphate of soda produces a precipitate in many acid solutions of metals, the phosphoric acid forming an insoluble compound with the oxide of the metal, while the soda unites with the acid of the metallic solution, and remains in the supernatant liquid: in this manner can be obtained, the phosphate of nickel from the sulphate, the phosphates of lead, quick silver, and silver from the nitrates, and the phosphate of cobalt, from the muriate.

Sal ammoniac.—Sal ammoniac was originally imported from Egypt, where it is obtained by subliming the soot obtained from chimnies, under which, as is usual there from the want of other fewel, the dried dung of animals has been burned, especially that of cows; 26 lb. of this soot yielded 6 lb. of sal ammoniac. At present, it is obtained by distilling the refuse of the slaughter houses, in large iron long necks; the watery liquor, impregnated with carbonate of ammonia and oil, that comes over, is then mixed with ground gypsum, a native sulphate of lime, by which a solution of sulphate of ammonia is formed, and carbonate of lime subsides, the two acids exchanging their bases; this sulphate of ammonia is then mixed with common salt, and exposed to heat, when another interchange of acids and bases takes place: the muriatic acid of the common salt, uniting with the ammonia and forming the sal ammoniac, which sublimes; while the sulphuric acid unites with the soda, and forms the Glauber's salt that constitutes the residuum. Some manufacturers impregnate animal matter with the mother water left after making common salt from sea water, which contains much muriate of magnesia; by exposing these impregnated substances to heat, sal ammoniac is formed: the animal matter furnishing ammonia, and the muriate of magnesia, at a red heat, muriatic acid.

Sal ammoniac, or muriate of ammonia, is very tough, and yields with difficulty to the pestle; hence the ancient chemists chose to pulverize it philosophically, by subliming it into a large glass globe, where it settled in flowers, as they were called. It is soluble in 3·25 times its weight of water, and is sometimes employed as an aperient and diaphoretic, but more commonly externally, in fomentations, as a discutient and resolvent, generally ℥ſs to a pint of water. In the arts it is used as a flux, or its solution in water to clean the surfaces of bodies.

Sal ammoniac, mixed with twice as much quick lime, and strongly heated, emits an acrid gas, which must be collected over quick silver, as water absorbs this ammoniacal gas, as it is called, very rapidly.

To obtain water impregnated with this gas, on 6 oz. of quick lime pour a pint of boiling water, and let it stand in a close vessel to cool; dissolve 8 oz. of sal ammoniac in 3 pints of water; mix the two liquors; pour off the clear, and distil 12 oz. measures of liquor ammoniæ, the specific gravity of which ought to be 0·960; the contents being 1 of ammonia to 9 of water. This ammonia water is used as a stimulant errhine in fainting fits, under the name of spirit of sal ammoniac. Modern chemists usually call it ammonia, and confound it with ammoniacal gas.

Sal ammoniac distilled with twice its weight of dried chalk, yields a sublimate called volatile sal ammoniac, and now, by the College, subcarbonate of ammonia, well known as an errhine. The residuum being dissolved in water, the solution filtered, and evaporated to dryness, is the muriate of lime; 2 oz. of which being dissolved in 3 oz. of water, and the solution again filtered, is the liquor calcis muriatis of the College, which is used as a deobstruent and laxative, in doses of gtt. 40 to ʒj, diluted with water, in scrofulous and glandular diseases. It is this salt that is now supposed to be the active ingredient in mineral waters. The rationale of these operations is alike: the lime unites with the muriatic acid of the sal ammoniac, and the ammonia is either set free, or unites with the carbonic acid of the chalk, that is disengaged at the same time. The muriate of lime is used in chemistry to absorb the water contained in gases, and to produce cold by its being dissolved in water.

Two lb. of sal ammoniac, mixed with 1 of sulphur, and 6 of slaked lime, yields a liquid hydrosulphuret of ammonia, which, notwithstanding its horrid smell, is much used as a precipitant in assaying ores and metallic alloys, by the moist way, or that of solution in acids; as the different colour of the sulphurets of the various metals that fall down affords considerable information.

Equal weights of sal ammoniac and carbonate of iron, being sublimed together, yield the ferrum ammoniatum of the Pharmacopœia; which is given in small doses as an astringent and deobstruent. The theory is obscure, for it is not certain, whether the product is an ammonia-muriate of iron, or a mixture of muriate of ammonia with muriate of iron, or whether any carbonate of ammonia is also mixed therewith.

Four oz. of sal ammoniac being dissolved in water, 6 oz. of corrosive sublimate added, and when dissolved, the solution precipitated by carbonate of potasse, the powder being well washed with water, is the white precipitate of the apothecaries; used externally, as a detergent in foulness of the skin, and to kill vermin in the hair. In this process, an ammonia-bimuriate of quick silver, called sal alembroth, is first formed; the potasse absorbs one portion of muriatic acid, the carbonic acid set free escaping in the form of gas: thus muriate of potasse and an insoluble ammonia-muriate of quick silver are formed; the former remains in solution, and is entirely separated by the washing, leaving the latter in the form of a white powder, distinguishable from calomel by not becoming black when rubbed with lime water.

Sal ammoniac added to nitric acid enables it to dissolve gold; if this solution is precipitated by carbonate of potasse, the yellow precipitate is not a carbonate or oxide, but an ammoniuret of gold, called fulminating gold, which explodes with great violence by a slight heat or friction.

A solution of sal ammoniac exposed to oxymuriatic or chlorine gas, absorbs it, and a kind of oil forms at the bottom of the solution. This nitro-muriatic oxide, or on the other theory, this quadri-chloride of azote, explodes with dreadful violence by a slight heat, or by the touch of several substances, as phosphorus, nitrous gas, liquid ammonia.

Ammoniacal Gas.—Ammoniacal gas, or alkaline air, as it was originally called, weighs about 42 gr. per gallon; an oz. of water will absorb about 5 gall. and an half of it, and form a solution, whose specific gravity is 0·875.

Ammoniacal gas having a series of electric sparks passed through it, is expanded to twice its original bulk, and is found by analysis, to be changed into a mixture of 3 volumes of hydrogen gas and 1 of azote.

Ammoniacal gas may also be changed into a similar mixture of hydrogen gas and azote, by being passed through a red hot tube.

Spirit of Sal ammoniac.—Spirit of sal ammoniac, made with quick lime, or liquid ammonia, is much used in chemistry, as a precipitant. Sometimes it seizes only part of the acid, as when added to a solution of blue vitriol, a sub-sulphate of copper falls down; sometimes the whole, as with muriate of tin, from whence it throws down a hydrate of the protoxide of that metal.

Spirit of sal ammoniac poured on the dark olive oxide of silver, that is obtained by adding lime water to the nitric solution of silver, dissolves a portion of it, a black powder being left which is highly explosive; azote and water are formed, and the silver is reduced to its metallic state.

Spirit of sal ammoniac added to a solution of sulphate of magnesia in water, only precipitates part of the magnesia, and the supernatant liquid is an ammonia-sulphate of magnesia, which crystallizes in octaedrons.

Spirit of sal ammoniac added to a solution of alum in water, throws down the alumine in combination with a portion of water, from which the earth may be freed by a strong heat.

Spirit of sal ammoniac forms with phosphoro-muriatic acid, or bichloride of phosphorus, a substance which remains unchanged at a white heat, and is insoluble in water; so that the fixity or insolubility of the earths and metals, is no argument against their containing volatile or saline elements, or being even composed entirely of such.

Volatile Sal ammoniac.—Volatile sal ammoniac, or carbonate of ammonia, called in the Pharmacopœia subcarbonate of ammonia, contains 43·5 per cent. of ammonia, and 56·5 of carbonic acid. It is very pungent, continually exhaling ammoniacal gas, until it loses one half of its ammonia, and is changed into bicarbonate of ammonia, which is scentless, and remains unchanged in the air. A pint of water dissolves about 4 oz. Troy of the carbonate, and thus forms spirit of hartshorn, or the liquor ammoniæ subcarbonatis of the Pharmacopœia, which is stimulant and antispasmodic, and may be given to ʒj; it is also used in gargles, ʒiij in lb. ſs of water or other liquid.

Volatile sal ammoniac is used in pharmacy to prepare the bicarbonates of potasse and soda, called in the Pharmacopœia carbonates. For the former, lb. j of carbonate of potasse being dissolved in water, 3 oz. Troy of volatile sal ammoniac are added, and the liquor is kept hot until all the ammonia is driven off, and then left to crystallize: by evaporation of the mother liquor, a second crop of crystals may be obtained. In like manner, the sodæ carbonas, or bicarbonate of soda, is obtained from the carbonate: both are used as antacids. In these processes the carbonic acid is transferred to the potasse or soda, and the ammonia is volatilized.

Volatile sal ammoniac added to nitric acid, diluted with water, until the acid is saturated, and the solution crystallized, yields nitrate of ammonia; which being exposed to heat is entirely resolved into nitrous oxide, or intoxicating gas, and water.

Volatile sal ammoniac added to spirit of salt, produces sal ammoniac, which may be obtained in crystals, by proper evaporation.

Carbonate of ammonia dissolved in diluted sulphuric acid, produces a salt called Glauber's secret sal ammoniac, which is a sulphate of ammonia.

Volatile sal ammoniac ground with two thirds its weight of blue vitriol, occasions an effervescence, owing to the escape of the carbonic acid; and the ammonia uniting with the sulphate of copper, forms a fine blue ammonia-sulphate of copper, called in the London Pharmacopœia cuprum ammoniatum: it must be dried between folds of blotting paper, to prevent the loss of the ammonia. This is used in epilepsy, in very small doses. A dram being dissolved in a pint of water, forms the liquor cupri ammoniati, used as an eye water.

Intoxicating Gas.—Intoxicating gas weighs about 107 gr. per gallon. Its taste is sweet, its smell agreeable; when respired it produces, in most, a pleasant exhilaration like intoxication, but without its disagreeable effects. It is absorbed by its own bulk of water, and is expelled by heat without alteration. When mixed with an equal measure of hydrogen gas, and set on fire by an electric spark, it forms water, and nitrogen equal in bulk to the original intoxicating gas; hence this nitrous oxide is a protoxide of nitrogen, and the hydrogen abstracting the oxygen, forms water.

Liquid ammonia and muriate of ammonia, or sal ammoniac, are employed in chemical researches, to obtain some of the metals in the purest state possible; but as this extreme purity is not required in pharmacy, or the common practice of the chemical arts, it is needless to detail the processes in this compendium.

Chromate of Iron.—Chromate of iron is a black mineral rather of a metallic appearance, hard enough to cut glass, and yielding a fine green glass when melted with borax. This mineral, on being heated with half its weight of nitre, then dissolved in water, and the excess of potasse, arising from the decomposition of the nitric acid into azotic and oxygen gases, saturated with fresh nitric acid, a solution of nitre mixed with a solution of chromate of potasse is obtained. On adding a solution of lead in nitric acid to this mixed solution, the chromic acid leaves the potasse, and uniting with the oxide of lead forms a beautiful yellow precipitate, called chrome yellow, which is much used as a paint; while the nitric acid leaves the lead to unite with the potasse and form common salt petre, which is separable by washing.

There are several other articles that belong to this division of the materia chemica, but they are used only for the extraction of certain rare substances, which are at present mere subjects of curiosity, and not of any use in the practice of medicine, or the arts: it is therefore fully sufficient to enumerate them:

German black lead, or the sulphuret of molybdene, used for obtaining	Molybdenum.
Wolfram	Wolframium.
Petalite	Lithium.
Yttrotantalite	Tantalum.
Hungarian red schorl	Titanium.
Saxon pech-blend	Uranium.
Transylvanian graphic ore	Tellurium.
Seleniuret of copper	Selenium.
Bastnaes cerite	Cerium.
Beryll	Glucine.
Gadolinite	Ittria and Thorina.

Berzelius's Laws of Combination.—Having thus obtained some insight into particular chemistry, a student is enabled to conceive some general laws, that appear to be observed in the chemical combination of bodies with one another, and to understand the doctrine of latent heat, or the capacity of bodies for acquiring and delivering heat.

Berzelius, who has particularly studied the laws of combination, has deduced the following propositions:

1. When two or more bodies, not containing oxygen, are united together, they are in such proportion, that in order to be oxygenized to a certain degree, they require, either equal quantities of oxygen, or quantities of which one is a submultiple of the other.

Sulphur, sulphuretted hydrogen, boracium, telluretted hydrogen, when united to oxides, are subject to the same laws as if they were united with the combustible base or its oxygen.

When two oxygenized bodies are combined together, the oxygen they contain determines the proportion in which they are combinable, being either equal in both, or in one a multiple by a whole number, of the quantity contained in the other. Thus, in the sulphites, phosphates, muriates, arseniates, borates, and carbonates, the oxygen in the acid is twice that in the base; in the sulphates, thrice; in the nitrites, supposing the existence of oxygen in azote or nitrogen, four times; in the nitrates, on the same supposition, six times; in the hyperoxymuriates, on the supposition of chlorine containing oxygen, eight times.

According to Berzelius's latest experiments, 100 parts of the sulphuric acid requires for its saturation, so much of any base as contains 19·26 parts of oxygen; 100 of sulphurous acid, 24·9; of phosphoric, 27·5; of muriatic, 29·454; of nitric, 14·65; of nitrous, 21·03; and of arsenic, 16·96.

When water is combined with acids, it may be considered as supplying the place of a base; and when combined with alkalies, as supplying the place of an acid. Few of the acids can exist in a perfectly pure state, but require some base, of which water being the weakest, it interferes the least with the results that a chemist wishes to obtain; and, therefore, acids are generally considered as pure when they contain only so much water as is necessary for their existence. The sulphuric, nitric, muriatic, and fluoric acids, in their dryest state, are united with as much water as contains the same quantity of oxygen as any other base with which those acids are unitable. The solid acids, as the boracic, contain also another portion of water, which is less intimately united with them, and may be expelled by heat; this portion of water serves for the crystallization of the acid, and thus renders it analogous to the crystallized salts, which contain, in like manner, a certain quantity of water.

When water is combined with bases, it in some measure supplies the place of an acid, but in a less perfect manner, and the proportion required is smaller. With potasse, soda, barytes, lime, magnesia, and alumine, there is required only so much water as contains a quantity of oxygen equal to that in the base; with oxide of iron, only so much water as contains half as much oxygen. Some of these hydrates, as those of potasse, soda, barytes, and strontian, do not part with their water, on being heated to redness; the others part with it by heat, and some hydrated oxides of the metals lose their water by being even merely boiled in water.

When two bases are combined together, the oxygen they respectively contain, is either equal in each, or that of the one is a multiple of that of the other; hence it is probable, that one assumes the character of a weak acid in respect to the other.

When two acids form a compound acid, the weaker appears to serve as a base; which is only separable from the stronger acid by means of some other base, or by the water which the acids divide between them.

When more than two oxygenized bodies unite together, the oxygen in that in which it is the least abundant is a submultiple of that which is contained in each of the others. Thus, in nitrate or muriate of ammonia, the oxygen of the water of crystallization is equal to the oxygen of the base; in sulphate of lime, sulphate of ammonia, or muriate of barytes, it is twice as much; in nitrate of bismuth, 3 times; in sulphate of copper, or sulphate of zinc, 5 times; in muriate of lime, 6 times; in green sulphate of iron, 7 times; in sulphate of soda, 10 times; in subsulphate of iron the oxygen of the water is equal to that of the oxide of iron and double that of the acid; in subsulphate of lead, the oxygen of the acid, or of the base, is 3 times that of the water; in alum, the oxygen of the alumine is 3 times, that of the sulphuric acid 12 times, and that of the water of crystallization 24 times as much as the oxygen of the potasse; in the ammonia-subsulphate of copper, the oxide of copper and the water of crystallization contain equal quantities of oxygen; the ammonia, supposing it contains oxygen, twice as much; and the sulphuric acid 3 times. Hence, if the quantity of oxygen in each of the proximate elements of a body compounded of acids or oxidized bases, be calculated, these quantities may all be divided by some common measure, and the several quotients will denote the charges of oxygen in each; from whence the real composition may be readily guessed.

From the quantity of ammonia required for saturating acids, it may, in consequence of this law, be inferred, that ammonia contains about 46 per cent. of oxygen; and its change into azotic gas and hydrogen gas, by being passed through a red hot tube, shows that this is united with 36 of nitricum and 18 of hydrogen, so that the composition of ammonia is 6 H + N + O. In like manner, as 100 parts of nitric acid saturates bases containing 14·5 or 14·6 of oxygen, it is requisite that the several nitric oxides and acids should be multiples of this number, which they are not if azotic gas be not esteemed a protoxide of nitricum, as is indicated by the analysis of ammonia.

It is most probable, that as 100 parts of muriatic acid saturates bases containing 29·45 of oxygen, it does itself contain twice as much oxygen as these bases, namely 58·9 per cent.; since the other supposition, of oxymuriatic acid gas being a simple body, called by the supporters of that opinion, chlorine, would afford a less regular progression in its compounds. It always contains a portion of water, the oxygen of which bears the same proportion to that of the dry acid, as that of any other base would, namely that it is equal to one half of the oxygen of the dry acid. As an example of these calculations, the present may be taken. Dry muriatic acid, then, according to Berzelius, containing M (= 139·36) + 2 O (= 200·00), the acid itself will be = 339·36; and water containing 2 H (= 6·26 × 2 = 13·272) + O (= 100) will be = 113·272; and the muriatic acid gas = 339·36 + 113·272 will be = 452·632; whence the 113 of water is equal to one third of the 339 of dry acid, or one fourth of the 452 of the acid as it exists in the gaseous form. Now, according to the ordinary rules, as 339·36 of the dry acid is to the 200 of oxygen that it contains, so is 100 of the dry acid to 58·9 of oxygen, as already mentioned: and, as in 100 of the muriatic acid gas 44·3 of oxygen will be found to be contained, united with 31 of muriaticum in the dry acid, and 22 of oxygen united with 2·7 of hydrogen in the water, it is evident, that the water is united with the acid in the same proportion as any other base would be, namely, so that the oxygen is one half that of the acid.

Latent Heat.—The chemical action of the bodies whose presence or absence has no effect upon the balance, belongs to the higher department of the science, rather than to the elementary; and, therefore, it is only necessary, at present, to give some slight account of the heat which becomes latent when bodies are melted, and the relative capacity of bodies to communicate heat to others.

Two similar vessels, one filled with ice at 32° Fahr. the other with water at 33°, were hung in a room whose temperature was 47°: in half an hour the water rose to 40°, that is, it had acquired 7° of heat; in ten hours and an half the ice was completely melted, and the water from it was at 40°. As the ice must have continued to receive heat at the rate of 7° by the half hour, it must have received (21 × 7 =) 147°; but as its temperature was only 40°, therefore 139 or 140° remains latent in the water, and is expended in maintaining its liquid state.

The heat that is thus absorbed when ice is melted into water, re-appears when the water is frozen; for if, when the atmosphere is at 22°, two open vessels, one of water and the other containing a saturated solution of common salt, both at 52°, are exposed to it, their temperature gradually sinks; that of the brine, without interruption, until it falls as low as the temperature of the atmosphere; but the water, as soon as it has fallen to 32°, remains stationary; the water slowly freezing, and thus parting with its latent heat, it maintains the temperature, so that it does not fall below the freezing point.

Again, if water in a covered vessel is exposed to the atmosphere at 22°, it will gradually cool to that point without freezing, so that the still liquid water will be actually 10° below the freezing point. If the water be then shaken, one fourteenth part of it freezes immediately, and the temperature of the whole rises suddenly to 32°. Here this fourteenth part is deprived of 13 times 10°, or 130°, to enable the other 13 parts to remain in the state of water, which 130° with the 10° it had previously lost itself, is equal to the 140° of latent heat required to keep ice in the state of water.

In like manner, snow at 32° being mixed with an equal weight of warm water at 172°, the snow instantly melts, and the temperature of the mixture is only 32°, whence 140° of heat have become latent, and have combined with the snow, merely serving for its melting without increasing its temperature.

The latent heat of fluidity has been found to be, in sulphur 143°, in lead 162°, in zinc 493°, in tin 500°, and in bismuth 550°.

Latent Heat of Steam.—A tin plate vessel of water, at 50°, being put upon a red hot iron plate, rose to 212°, or the boiling point, in four minutes, when it remained stationary, and was all boiled away in 20 minutes; hence, as it received heat at the rate of (212—50=) 162° in 4 min. the quantity of heat which was absorbed and expended in the formation of steam, must have been (162 × 5 =) 810°, for the temperature of steam in an open vessel is the same as that of boiling water.

Water may be heated in a close vessel to 400°, without boiling; if the vessel is then opened, one fifth of the water rushes out in the form of steam, and the temperature instantly sinks to 212°, so that 188° instantly disappear; hence the steam must have combined with 5 times 188°, or 940°, which is expended in maintaining its vaporous state without augmenting its sensible heat.

The steam of boiling water was directed by a tube into 8 oz. Troy of water at 50°, until the temperature rose to 173°: the water was found to have condensed 8·5 drams by weight of steam; now, although the absolute quantity of heat contained in different bodies, cannot be determined at present, yet if their weights be multiplied by the temperature, the products will afford a comparative measure of the heat they contain. Hence, if from (72·5 drams × 173° =) 12542·5 the whole heat at the end, there be subtracted (64 × 50 =) 3200 the heat of the original cold water, there will remain 9342·5 for the heat of the steam that was condensed, which being divided by 8·5, the weight will give 1099° for the temperature, from whence subtracting 212°, the sensible heat, there will remain 887° for the latent heat of the steam.

A gallon of boiling water added to 100 gall. of water at 50°, raises the temperature 1·5°; but a gallon of water being distilled, will raise the temperature of 100 gall. of water in the worm tub 11°, or 9·5° more than by boiling water, whence the latent heat of steam appears to be (9·5 × 100 =) 950.

Water converted into steam melts 7·5 times its weight of ice; whence, as the ice requires 140° for its liquefaction, the latent heat of the steam must be (140 × 7·5 =) 1050°. All these determinations of the latent heat of steam, although they differ from one another, yet agree in pointing out 950° to 1000° as the probable limits in common circumstances.

The above experiments are mostly Dr. Black's. Dr. Ure has determined the latent heat of the vapour of liquid ammonia, sp. grav. 0·978 to be 837°, and that of the vapour of nitric acid, sp. grav. 1·494, to be 532°.

Capacity for Heat.—If two substances which have no chemical action upon each other, and having different temperatures, are suddenly mixed, the resulting temperature is not the mean term betwixt the two temperatures, although the weights may be the same. Thus, if 1 lb. of water at 100° be mixed with 1 lb. of quick silver at 40°, the resulting temperature will be 97·5°: hence, although the water loses only 2·5°, yet the matter of heat or caloric, which it has parted with, raises the temperature of the quick silver no less than 57·5°; from whence, by the rule of three, it will be found that the quantity of caloric necessary to raise the temperature of any portion of water 1°, would raise the temperature of the same weight of quick silver 23°; and, of course, if the quantity of caloric necessary to raise any quantity of water any number of degrees, be taken as the unit of the capacity of bodies for receiving heat, that necessary for raising the temperature of a similar weight of quick silver a similar number of degrees, will be expressed by the 23rd part of an unit, or 0·0434.

This capacity is by some called the specific heat of a body. It is easy to determine the specific heat of a body, by mixing it with water at certain temperatures, then multiplying the weight of the water by the difference between its temperature before and after mixture; and secondly, multiply, in like manner, the weight of the other substance, by the difference produced in its temperature. If the first product be divided by the second, the quotient is the specific heat of the substances, that of water being unity. Thus, in the preceding experiment, 12 oz. of water having lost 2·5°, the weight multiplied by the difference of temperature is 30, and 12 oz. of quick silver having gained 57·5°, the weight multiplied by the difference will produce 690: whence, dividing the first number 30, by the second 690, the quotient 0·0434 will express the capacity or specific heat of the quick silver.

The following is the specific heat or relative capacity for receiving heat, in the same weight of the most common substances hitherto mentioned.

Air	0·2669	Gold	0·0500
Hydrogen gas	3·2936	Tin	0·0650
Carbonic acid gas	0·2210	Oxide of tin	0·0960
Oxygen gas	0·2361	Antimony metal	0·0645
Azote	0·2754	Oxide of antimony	0·2272
Water	1·0000	Iron	0·1260
Steam	0·8470	Oxide of iron	0·3200
Ice	0·8000	Rust of iron	0·2500
Charcoal	0·2631	Copper	0·1000
Sulphur	0·1880	Oxide of copper	0·2272
Sulphuric acid.		Brass	0.1150
Sp. gr. 1·885	0·7580	Chalk	0·2564
Sp. gr. 1·872	0·4290	Quick lime	0·3000
Sp. gr. 1·844	0·3500	Stone ware	0·1950
S. A. 4, water 5	0·6631	Glass	0·1800
S. A. 4, water 3	0·6031	Nitric acid	0·6300
S. A. 18, water 10	0·5200	Muriatic acid	0·5860
Quick silver	0·4340	Potasse ley	0·7590
Lead	0·0400	Liquid ammonia	1·0300
Oxide of lead	0·0680	Common salt	0·2303

The most striking observation to be made on this table, is the increase of the capacity caused by the union of oxygen with any body.

Absolute Heat.—As to the absolute quantity of heat existing in bodies, or the point of absolute cold, on the thermometric scale, no means of determination have yet been discovered ; although several speculations have been sported on the subject.

Mixtures producing Cold.—When bodies that act chemically upon one another, are mixed together, a still greater alteration of temperature takes place ; sometimes the resulting temperature is far below that of either of the ingredients, and at other times it rises far above the temperature of the hottest, and is attended with the emission of heat and light, or even flame.

The most striking examples of the first kind, are the mixtures used by chemical lecturers to produce cold, which are, for the most part, the solution of salts in water. The salts should be finely powdered, the solution promoted by stirring, and made in a very thin vessel, that this may have but little effect on the materials.

5 oz. each of sal ammoniac and salt petre, dissolving in a pint of water, all at 50°, sink to 10°; so that 40° of heat are lost.

9 oz. hosphate of soda and 6 oz. of nitrate of ammonia,

dissolving in 4 oz. of diluted nitric acid, will sink from 50° to 21° below zero; so that 71° are lost.

6 oz. Glauber's salt, 4 oz. sal ammoniac, and 2 oz. of salt petre, dissolving in 4 oz. diluted nitric acid, will sink from 50° to 10° below zero, suffering a loss of 60°.

5 oz. Glauber's salt, dissolving in 4 oz. dilute sulphuric acid, will sink it from 50° to 3°, suffering a loss of 47°.

1 lb. of common salt mixed with 2 lb. of snow, or pounded ice, will sink from any ordinary temperature to 5° below zero.

10 oz. common salt, 5 oz. each of sal ammoniac and salt petre, mixed with 24 oz. of snow, or pounded ice, will sink from any ordinary temperature to 18° below zero.

The above are the salts most ready at hand; by using others and cooling the substances previously to admixture, the temperature has been sunk to 91° below zero.

Mixtures producing Heat.—Mixtures that produce heat are usually those in which oxygen gas, or bodies that contain a large proportion of it, at least in a certain state, unite with non-oxygenized bodies, such as hydrogen gas, sulphur, or the metals: although some other admixtures will produce considerable heat.

4 oz. oil of vitriol, mixed with 1 of water, at 50°, raises the temperature to 300°.

Oil of vitriol poured upon one sixth of its weight of calcined magnesia, in a shallow cup, produces a red heat. A similar red heat takes place on pouring oil of vitriol on lime, or on barytes.

Water poured upon quick lime, produces so much heat that lime barges have sometimes been set on fire by the water oozing in at some leak.

These are usually explained by alterations taking place in the capacity of the substances for containing caloric.

Inflammable Bodies.—Other substances, when heated to a certain point in atmospheric air, or oxygen gas, take fire, and the combustion then goes on, until the whole of the combustible has combined with the oxygen, or absorbed it from the air.

Sulphur, heated in atmospheric air to 560°, takes fire and is entirely consumed.

Phosphorus in air takes fire at 148°.

Charcoal at 800°.

Potassium at a red heat.

Zinc at a heat above redness.

Iron wire, heated at one end to redness, and plunged into oxygen gas, burns with a most intense vivid light, and much heat is produced.

Theory of Combustion.—These processes, and those in which substances unite with oxygen at a red heat without the emission of light, have been explained variously. Some of the ancients considered only the combustion of sulphur or charcoal, or the phenomena occurring in the combustion of wood in which the residuum is either invisible or so small in quantity that it may be regarded only as an impurity, and therefore supposed that fire was an element which had the property of converting other substances into its own nature: while the phenomena occurring in the exposure of metals to air and fire, were regarded as analogous to those taking place in the making of quick lime, in Latin calx viva; hence the products were denominated the limes, or in Latin the calces, of the respective metals, and the difference between metals and their calces was ascribed to the fire they absorbed.

As soon, however, as experiments began to be made on the weights of the products, and on the differences of the substances which had been confounded under the name of air, this theory was necessarily neglected. The similarity between metals suggested the existence in them of a common principle of combustibility, called phlogiston, which escaped in calcination. Stahl thought this was similar to charcoal or lamp black, as these reduced the calces to the metallic state, and left no visible residuum; but some, as Macquer, assimilated the principle to light. On the other hand, the increased weight acquired by metals in calcination suggested to Hooke, Bayen, and Lavoisier, the absorption of air, as being the cause of the phenomena; and this opinion was strengthened by the diminished bulk of air in which candles had burnt, or metals had been calcined. The increased heat and the light emitted, were either considered as motions only, as by Hooke and the followers of Lavoisier; or thought to be contained in the air, to which they gave its air-like form, as by Lavoisier himself.

Scheele having imbibed in his youth the then prevalent idea of a common principle of combustibility, considered all combustible bodies to be composed like sulphur or phosphorus, on the Stahlian theory, of an acid and phlogiston;

and thought, that when the temperature of combustible bodies was increased to a certain point, in contact with atmospheric (called by him fresh) air, they are decomposed: the phlogiston uniting with one of the component parts of the atmospheric air, oxygen gas, called by him fire air, forms heat, which adheres to the other component part of atmospheric air, nitrogen gas or azote, called by him foul air, and rising up with it communicates the heat to other bodies; the combustion becoming more rapid, phlogiston is disengaged from the combustible in greater abundance, and forms, first, radiant heat, another compound of oxygen, containing a larger proportion of phlogiston, which radiates in all directions, is reflected by metallic substances, but on a transparent body, as glass, being opposed to it, is left on the glass; and, secondly, light, another similar radiating compound of oxygen, and a still larger proportion of phlogiston, which passes through transparent bodies, being inflected in various degrees, and thus separable by the prism into different coloured rays, containing various proportions of phlogiston, the violet rays possessing the greatest quantity, and this has also the strongest power in reducing certain metallic salts, as luna cornea, muriate (or chloride) of silver. Light, not interrupted in its passage, produces neither heat nor cold, but when it falls on a body to which it has an attraction, part of its phlogiston is deposited, and it is changed into heat. It does not pre-exist in bodies, as was supposed by Meyer; for, when sulphur or phosphorus is decomposed by nitric acid, no light is disengaged. The increase of weight that takes place in metals, during their calcination, is either owing to the oxygen of the atmosphere uniting with their phlogiston, and lodging in them in the form of heat, in consequence of their increased capacity for retaining heat, or to the oxygen they obtain from the decomposition of the fire by which they are calcined, in exchange for the phlogiston they give out to the surrounding air. In dissolving metals in acids, the disengaged phlogiston unites in some cases with the acid, as when the nitric acid is used, forming nitrous gas or the like; or if it has but little attraction for the acid, as when the diluted sulphuric acid is used, the phlogiston unites with the latent heat contained in the metal, and forms another compound of oxygen, with a still greater proportion of phlogiston than in light, namely, inflammable air, or hydrogen gas, which is sufficiently gross to be contained in vessels and affect the balance. He expressly states, that hydrogen gas is not unmixed phlogiston; for, if it were, it would be separated by all acids, in the same manner as aërial acid, or carbonic acid gas is from chalk. The acid, however, does not contribute to its formation, because it may be obtained by distilling zinc filings with pure hydrate of potasse, or by dissolving zinc in spirit of sal ammoniac. Hydrogen gas burned in oxygen gas is entirely consumed without forming aërial acid, and the two airs are thus resolved into heat and light. Here the usual simplicity of Scheele's apparatus, the experiment being made by burning a stream of hydrogen gas in oxygen gas contained in a jar standing in water, occasioned him to miss the discovery of the deposition of a quantity of water equal in weight to that of the two gases. We cannot, therefore, affirm how far this might have altered his sentiments. Considering his preconceived opinions, he would, perhaps, have thought the water to be a still grosser compound of oxygen gas and phlogiston; or perhaps, that water was the ponderable basis of both oxygen and hydrogen gas, which rendered them coercible in vessels, and was deposited during the combustion and consequent formation of radiant heat and light. I have been the more particular in giving an abstract of his opinions, because they have been misrepresented, and it has been said that he considered hydrogen gas as pure phlogiston.

Cavendish inclined to the opinion, that water was the ponderable matter of hydrogen gas, the other element being phlogiston. He showed, that the ordinary phenomena of chemistry may be explained, either by admitting a common principle, as phlogiston, existing in combustible bodies, or on Lavoisier's hypothesis of its non-existence. He himself gave the preference to the supposition of its existence; and when we consider the high estimation due to his judgment, it is sufficient to make us pause before a contrary opinion can be admitted. Kirwan, more remarkable for his great reading than for his judgment, from the crude experiments of Priestley, attempted to invalidate the opinions of Lavoisier, and to prove that hydrogen gas was the common principle of combustible bodies, heretofore called phlogiston. The French chemists entirely overturned his opinions on this subject, and elated with their victory, celebrated their triumph, by Madame Lavoisier, in the habit of a priestess, burning the Fundamenta Chemiæ of Stahl on an altar, while a band of music played a solemn funeral air over the flaming volumes.

The heat and light emitted in combustion having been purposely slurred over by the disciples of Lavoisier, or their materiality denied, has always been a defect in their theory. Since that time Dr. Thomson has endeavoured to show that light probably exists in all combustible bodies, giving them their peculiar colours, and that a considerable charge of heat exists in oxygen, and most of its compounds, as also in chlorine and iodine; and that in combustion, the light and heat uniting together form fire, while the ponderable bases unite also at the same time. To avoid the odium which the opinions of the day, still guided by the French school, have attached to the name of phlogiston, he carefully avoids giving that name to the common principle of combustible bodies, choosing rather to endure the equivocal use of the same word to express both the dormant and active state of the material intermedium of vision. As the properties ascribed to combined light are the same as those attributed to phlogiston, this seems an useless sacrifice to popular, or, to speak more correctly, to party opinion. What can it import whether we denote that matter which is found in all combustible bodies, by a Saxon word, light, or by a phrase of Latin origin, the principle of combustibility, or by a word derived from the Greek, phlogiston, when the meaning is in all cases the same?

Berzelius has endeavoured to explain combustion, by supposing intense electrical actions taking place in the union of bodies, in consequence of oxygen being naturally negative, and the combustible bodies positive.

Bodies firing by Flame or Electricity.—There are other bodies that will take fire at any common temperature, by the contact of actual flame, or an electric spark, as hydrogen gas with common air or oxygen.

Bodies exploding by a Spark.—Other bodies, as gunpowder, and similar compounds of salt petre, explode with violence by the contact of an ignited body, or a flint spark; and although they produce gases many times exceeding their original bulk, much heat is disengaged, contrary to the general theory of latent heat, in which gases are supposed to absorb great quantities of heat to acquire the aëriform state. Chemists, therefore, have supposed that nitric salts contained heat (fire), as a constituent element; and Brugnatelli, conceiving that it was introduced into them with the oxygen, gave, as we have already said, the name of thermoxygen to this compound of oxygen and combined heat. These combustions are considered by some, as apparently still less reconcilable with the doctrine of the immateriality of heat than the preceding; for, although they can conceive how heat, supposing it a motion, may, when once excited by an adequate agency, be kept up nearly at the same intensity for some time, or may be suddenly diminished, yet that the motion of the particles in a flint spark should communicate a similar motion to an immense mass of gunpowder, and resolve it into permanent gas, is beyond their conception, and appears to them contrary to the laws of the communication of motion. The favourers of the hypothesis of heat being motion, are supposed to have confounded combustion and ignition, and to have reasoned from the appearances of red hot substances, not actually burning and combining with the air.

Bodies firing by Contact.—Other bodies produce fire, or the emission of heat and light, by contact with certain bodies that are supposed to contain oxygen, as potassium and sodium take fire by contact with water; and moist nitrate of copper, on being wrapped up in tin foil, produces heat, vapours of nitrous acid, and at last the foil bursts open and takes fire. Here, again, it is said that we must allow combined heat and light in some of the bodies.

Bodies emitting Light at a certain Temperature, and uniting.—There are certain substances, again, which when heated in close vessels without air or oxygen, do, at a certain temperature, unite and emit light: such as sulphur and copper filings, sulphur and iron filings, which emit a purplish red light; sulphur and lead filings, which emit dark red light. These were explained on the supposition, that the compound contains less phlogiston than the ingredients: the chemists of the other party explain them by a difference in the velocity, or some other modification, of the motion from that which constitutes heat.

Bodies suddenly changed without Loss of Weight.—Another class of substances, as some of the oxides of antimony, of chrome, and of rhodium, on being heated to a certain temperature, suddenly become ignited, and undergo some change in their chemical properties, becoming less soluble in acids, or the like, without any discernible difference taking place in their weight. These phenomena, had they been known to Scheele, would probably have been explained by him on principles similar to the preceding.

These are the principal appearances that occur in the mixture of bodies, when such admixture produces an increase of temperature. It is evident, that the explanations hitherto offered, are defective in some one point or another, or they form an anomaly, as in the case of the immateriality of heat, when compared with the other parts of the science.

It seems requisite, therefore, that the whole doctrine of the elements which do not affect the balance, should be carefully reviewed, and the appearances being reduced to certain classes, that an explanation in detail of each class should be attempted on all the theories hitherto proposed; in order that by comparing them, it may be discovered which presents the fewest anomalies, and unites the best with the received doctrines of the appearances taking place in the admixture of those substances that are cognizable by their weight.

Compound Combustibles.—The more simple substances being thus gone through, it remains only to treat of those compound combustibles, which are, generally speaking, produced in organic bodies, or from bodies having that origin. Some of them, indeed, are so loaded with water or other incombustible matter, as vinegar or oyster shells, that they appear, to a common observer, to be themselves incombustible; but when the water or other extraneous matter is separated, this appearance vanishes. In point of chemical composition, they are, generally speaking, compounds of carbone, hydrogen, and oxygen, to which are sometimes added nitrogen and other ingredients: hence they are distinguished from the combustibles of the former series, in always forming both carbonic acid and water by their union with more oxygen.

Chemists, properly so called, pay little attention to these compounds, and attach themselves more to the supposed proximate principles which they affirm they separate from organized bodies; but, as they cannot re-make the original compound by the union of these proximate principles, there is reason to believe that they are, in most instances at least, new products rather than principles. Of these proximate principles, as they are called, nearly 140 are enumerated, viz.

Acid Combustibles.—About 40 acids.

The aceric from the sap of the maple.

The acetic, from vinegar; to which, perhaps, the lampic acid may be reduced.

The amniotic, from the liquor in the amnios of kine.

The boletic, from a species of mushrooms.

The benzoic, usually called flowers of benzoin; an impure species of which was formerly distinguished as the sebacic, from tallow or fat by distillation.

The bombic, from a species of caterpillar.

The camphoric.

The cetic, from spermaceti.

The citric, from lemons.

The caseic, from cheese.

The cevadic, from Indian caustic barley, or sebadilla.

The ellagic, from nut galls.

The fungic, from mushrooms.

The formic, from ants; which seems to have been frequently taken for the acetic.

The ferro-cyanic, from Prussian blue.

The gallic, from nut galls.

The hydrocyanic, or prussic, from dried blood, and most animal substances.

The igasuric, from St. Ignatius's beans.

The kinic, from Peruvian bark.

The laccic, from stick lac.

The lactic, from sour whey.

The lithic, formerly called the uric, from the calculi found in the human bladder.

The malic, or sorbic, from the juice of unripe apples or services.

The melanic, from black urine.

The moroxylic, from the saline exudation of the white mulberry tree.

The mucic, formerly called the saclactic, from sugar of milk, or from gum.

The margaric, from the pearly matter formed when soap is dissolved in water.

The meconic, from opium.

The melassic, from treacle.

The melittic, from a fossil resin called honey stone.

The menispermic, from cocculus Indicus.

The oleic, from oils; and whose combinations with potasse or soda are called soap; it having itself the appearance of oil, and usually considered as such.

The oxalic, from the juice of wood sorrel, or from sugar.

The purpuric, from the uric and nitric acids.

The pyromalic, from malic acid by distillation.

The pyrotartaric, from cream of tartar by distillation.

The rosacic, from the brick-coloured sediment of urine at the crisis of fever, or in the going off of a paroxysm of the gout.

The suberic, from cork, by nitric acid.

The succinic, from amber.

The sulphochyazic acid, from the yellow prussiate of potasse and sulphur.

The sulphovinic, from oil of vitriol and spirit of wine.

Alkaline Combustibles.—Secondly, about a dozen of combustible alkalies, most of which are extracted from the vegetables whose powerful action on the human frame has procured them the name of poisons: as,

Atropine, from belladonna.

Aconita, from monks hood.

Brucine, from false angustura bark, or brucia antidysenterica.

Cicutine, from hemlock.

Delphia, from the seeds of staves acre.

Datura, from stramonium.

Hyoscyama, from henbane.

Morphia, from opium.

Cinchonia, from red bark.

Quina, from yellow bark.

Emeta, from ipecacuanha.

Picrotoxia, from cocculus Indicus.

Sebadilline, called also veratrine, from Indian caustic barley, white hellebore, and the roots of meadow saffron.

Strychnia, from St. Ignatius's beans and nux vomica.

Solana, from night shade and bitter sweet.

Gentiana, from yellow gentian.

Piperine, from pepper.

Capsicine, from Guiney pepper.

And an alkaline substance obtained from uric acid.

Many of these are more analogous to resins, than to the common alkalies; but they saturate acids.

Alkohol.—Thirdly, a principle miscible with water in every proportion, very inflammable, and by combustion producing only water and carbonic acid gas, without any coaly residuum or soot, viz. alkohol of wine, or the highest rectified spirit of wine; very similar to which, is the pyro-acetic spirit obtained from the acetates by distillation.

Gummy Combustibles.—Fourthly, upwards of 40 combustible principles, which if solid, are soluble in cold water. These include,

The tanning matter of nut galls.

——————— of cutch, or Japan earth.

——————— of gum kino.

——————— of sumach.

——————— of old fustic; all of which are different species.

The artificial tannins procured from charcoal.

——————————— from indigo, by nitric acid.

——————————— from camphire, by the sulphuric and nitric acids.

The sugar of the cane or maple.

———— of grapes.

———— of starch.

———— of manna.

———— of milk.

———— of honey.

———— of mushrooms.

———— of diabetic urine.

A species of sugar brought from Botany Bay.

Sarcocolla.

Liquorice.

Gum Arabic.

Gum kuteera.

Mucus of lint seed.

——— of animals.

Jelly of currants.

Ulmine, from the elm.

The colouring matter of saffron, called polychroite.

——————— of logwood, called hæmatine.

Quassine, or the bitter principle of quassia wood.
Scillitine, or that of sea onions.
Caffein, or that of coffee.
Daphnine, or that of daphne Alpina.
The yellow bitter principle of indigo.
Picromel, or that of the bile.
Nicotine, the specific principle of tobacco.
The extractive matter of common barks.
——————————— of cutch.
——————————— of senna.
——————————— of Peruvian bark.
Burnt starch, called British gum.
The sweet principle of oils.
Uncoagulated albumen, or serum.
Osmazome, or the specific principle of animal broths.
Nefrine, formerly called urea, the specific principle of urine.
Cochenilline, carminium, or pure carmine.
The colouring matter of blood.
That of the cuttle fish ink, called sepia.
And that of the buccinum, the Tyrian purple of the ancients.

Starch-like Combustibles.—Fifthly, rather more than 20 similar principles, as they are called, which differ from the preceding in not being soluble in cold water, but dissolving, at least in certain states, in hot water: as,

Asparagine, obtained from the juice of asparagus.
Cerasine, prunine, or tragacanthine, the specific matter of cherry-tree gum, and tragacanth.
Starch, amyline, or amidine.
Starchy lignine; obtained from starch itself.
Inuline, or the starch-like matter of elecampane root.
Arrow root, or potatoe starch.
Sago.
Salep.
Tapioca.
Sowans.
Indigo.
The green matter of indigo.
The red matter of the same.
Gliadine, from gluten of wheat.
Zimome, from the same.
Fermented gluten of wheat.

The green fecule of plants.
Pollenine, or the specific matter of the pollen of the fir.
The white crystals obtainable from tincture of woad.
Gelatine, or glue.
And coagulated albumen.

Rosin-like Combustibles.—A sixth class of these supposed principles is formed of those that are not soluble in water, which if solid melt by heat; most of them are soluble in alkohol, and have a peculiar appearance. This class comprehends nearly 30 species:

The oil obtained from vegetables by distillation.
That of animals, by the same process.
Bees wax.
Myrtle wax.
Brazil wax.
The butter of roses.
Camphire.
The camphire contained in some essential oils.
——————— from oil of turpentine and muriatic acid.
Bird lime.
Olivile, or the crystals obtained from a tincture of olive-tree gum.
The specific matter of rosins.
————————— of stick lac.
Copal.
Amber.
Petroleum, or nafta.
Asphaltum.
Perhaps some other bituminous principles.
Gum guaiacum.
Indian rubber, called by the French caout chouc.
A rosin produced by digesting bitumens in nitric acid.
The elatine obtained by Dr. Paris from elaterium.
Narcotine, obtained from opium.
The cystic oxide; a species of calculus, discovered by Dr. Wollaston.
The butter-like substance obtained from elecampane root.
The specific matter of Spanish, or blistering flies.
Spermaceti.
The kind of spermaceti, called adipocire, into which flesh is converted, in water.
The oil obtainable from ants by boiling in water.
The rosin of the red ants.
Elain, or the liquid portion of the various fats and butters.

Stearine, or the solid part of fats and butters.

The poisonous oil of helleborus hyemalis, tobacco, and many other plants.

Fibrous, or wood-like Combustibles.—The last class of these combustible substances, obtainable from organized bodies, and conceived to be the proximate principles from which they are composed, contains only half a dozen species, which are of a woody or fibrous texture, and are insoluble either in water or alkohol: namely,

Lignine, or the pure woody skeleton of plants, of which white linen thread may be conceived to be the most pure specimen.

Cotton.

Fungine, the specific matter of mushrooms.

Suberine, that of cork.

Medulline, or the pith of the sun-flower stem, and of other plants.

And fibrine, or the fibrous part of blood; which is obtainable also from flesh, by long soaking and boiling in water, to separate all the soluble matters.

Pharmaceutical Division of Combustibles.—Many of the proximate principles are of no use in medicine; and, indeed, they are so numerous, that but few of them are usually examined, or even known, by the generality of chemists. Pharmaceutical chemists, therefore, pay most of their attention to the productions of nature, or of the manufacturers, which are used in their art. Hence, the divisions which the pure chemists have formed, are not followed in this work. Spirit of wine and vinegar, being of continual use in chemistry, as agents in the preparation and examination of bodies, are first noticed; and the remainder of the combustible bodies are arranged according to their taste, as being the quality that is usually first attended to in examining them, and which has also a considerable connexion with their medical virtues. For the sake of elementary brevity, scarcely any other of these articles, but those enumerated in the Materia Medica of the London College of Physicians, are noticed. The arrangement of these combustible drugs is as follows:

1. Earthy and absorbent bodies.
2. Farinaceous, mucilaginous, gelatinous, gummy, and emollient bodies.
3. Bitter bodies.

4. Austere and acerb bodies.
5. Acid bodies.
6. Aromatic bodies.
7. Fat and oily bodies.
8. Sweet bodies.
9. Acrid bodies.

Spirit of Wine.—Spirit of wine, as it is called, was formerly, and is still in southern countries, obtained by distilling wine for its yield of brandy, and then slowly abstracting the more volatile part of the brandy, by a small fire and the use of tall vessels. In England, spirit of wine is, in general, obtained from ground meal, either of wheat, rye, or barley, with from one tenth to one third of the same, or another grain, malted and ground, and then called malt spirit; or from treacle, and then called melasses spirit; some is also made from apples, or cyder wash. The fermentation is carried on quicker and farther than in brewing or making cyder, in order that all the sugar in the wash may be converted into spirit and water. The infusion of the malt and meal is made so strong, that its specific gravity is from 1·084 to 1·11, (whereas that for strong ale, is generally 1·06, and for small beer, 1·015 to 1·04), and is mixed with a large quantity of yeast, added by successive portions, until, in about ten days, the specific gravity is reduced to 1·002, when it is fit for the still. In general, a third part is drawn off at the first stilling, under the name of low wines, the specific gravity being about 0·975. On re-distilling the low wines, a fiery spirit, of a milky cast, comes over first, and is returned into the still: then follows the clean spirit; when it begins to grow too watery, the remaining spirit that comes over, as long as it will take fire, is kept apart, under the name of faints, and mixed with the next parcel of low wines. Instead of these trials, the head of the still may have the bulb of a thermometer inserted into it, and by observing the temperature of the steam, an accurate judgment may be formed of the strength of the spirit that distils over. It is computed, that 100 gallons of malt, or corn, wash, will produce about 20 of spirit, containing about half its weight of water; melasses wash, 22 gall.; cyder wash, 15 gall. The best French wines yield from 20 to 25 gall. The spirit thus obtained is, for chemical and pharmaceutical purposes, mixed with water, to separate the oil it contains, and re-distilled several times in tall vessels, with a very gentle heat until its specific gravity is reduced to 0·82; though that usually sold, is only 0·837, at 60° Fahr. By distilling spirit of wine with purified pearl ashes, salt of tartar, muriate of lime, lime, or common salt, all previously heated to redness, and cooled, its specific gravity may be reduced still lower, even as low as 0·792, at 68° Fahr.; but there is reason to think, that it not only parts with water, but also undergoes some change, or acquires some impregnation, by these additions, as its taste is altered. This spirit of wine, from which every particle of water is separated, is called by the Arabic name of alkohol.

In the London Pharmacopœia, spirit of wine of three strengths is ordered: namely, alkohol, sp. gr. 0·815; spiritus rectificatus, sp. gr. 0·835; and spiritus tenuior, sp. gr. 0·93; the latter, usually called proof spirit, is generally made, when wanted, by mixing what the distillers call spirit of wine, with an equal measure of water.

Spirit of wine remains liquid in the greatest cold hitherto produced, although it has been announced, that a cold of 110° below 0° Fahr. caused the separation of a yellow oil, and another substance not mentioned, from it. When of the sp. gr. of 0·8, it boils at 173·5° Fahr.; in a vacuum it boils at 56°. It mixes in every proportion with water, and the specific gravity of the mixture is always greater than the arithmetical mean. The specific gravity being used to regulate the price of spirit of wine in its usual diluted state, and the duties to be levied upon it, numerous experiments have been made to investigate the specific gravity of mixtures of the strongest spirit, with different proportions of water. The series of experiments made in England is the most complete; but unfortunately, the experimenters, in their zeal for extreme accuracy, forgot that spirit of wine is sold, and the duty on it paid, by measure; so that, as their mixtures were made by weight, the results they obtained are not those required by the distiller or the government, and can only be serviceable to them, by affording data for calculations. The experiments of Tralles of Berlin, although not so extremely accurate, are better adapted for use, as the mixtures were made by measure. The following is part of his table, showing the quantity of alkohol in 100 measures of a mixture having the quoted specific gravity, at 60° Fahr. proceeding by tens as far as 80 per cent. instead of units, as in the original.

Alkohol, per cent. by measure	Specific gravity	Alkohol, per cent. by measure	Specific gravity
Water	0·9991	85	0·8488
10	0·9857	90	0·8332
20	0·9751	93	0·8230
30	0·9646	95	0·8157
40	0·9510	96	0·8118
50	0·9335	97	0·8077
60	0·9126	98	0·8034
70	0·8892	99	0·7988
80	0·8631	Alkohol used	0·7936

The content per cent. of alkohol, for intermediate proportions, may be had by interpolation without any material error, as the utmost difference will be 0·0001, or 0·0002, and the specific gravity is seldom, or even never in business, taken to that exactness.

Spirit of wine, when pure, takes fire very easily, and burns entirely away, with a blue flame, 100 gr. producing 132 of water, in consequence of the hydrogen it contains uniting with the oxygen of the atmosphere, while the carbonic acid gas, which is also formed, escapes. It is distillable without any alteration, but on passing the vapour through a red hot porcelain tube, a little charcoal and oil was deposited, and the spirit was converted into an inflammable gas, called olefiant gas, and water. By this mode of analysis, the pure spirit was found to consist of 51·98 per cent. of carbone, 13·7 of hydrogen, and 34·32 of oxygen; which reduced to charges, is $2\,C + 3\,H + O$; or, perhaps, $2\,C\,H + H'$; that is to say, one charge of olefiant gas united with one of water.

Spirit of wine dissolves only a minute proportion of sulphur or phosphorus, but it dissolves potasse and soda very readily, forming a reddish acrid solution; that of potasse was used in medicine, under the name of tincture of antimony, the potasse being then prepared by detonating regulus of antimony with salt petre.

The saline bodies are some soluble in spirit of wine, and others not soluble; none of the sulphates are soluble therein; nor does spirit dissolve common salt, the carbonates of potasse or of soda, the nitrate of quick silver, or the muriates of silver or of lead, or borax. The spirit that has dissolved other salts retains its inflammability, but nitrate of strontian tinges its flame purple; muriate of lime, red; salt petre, and corrosive sublimate, yellow; and boracic acid, and the salts of copper, give the flame a green colour.

In the Pharmacopœia there are enumerated the tinctura ferri ammoniati, tinctura ferri muriatis, and the liquor hydrargyri submuriatis: as also, the spiritus ammoniæ, in the preparation of which last, spirit of wine being added to sal ammoniac and purified pearl ash, and distilled, the ammonia that is disengaged unites with the spirit of wine, as they distil over together.

Spirit of wine is decomposed when heated with sulphuric acid, or by nitric acid, in the common temperature of the atmosphere; but although the other acids, except the phosphoric, freely unite with spirit, they do not form a combination with it.

Ether.—The old chemists, after mixing spirit of wine with an equal weight of oil of vitriol, digested it for a long time, and then distilled the most volatile part, which was called the sweet oil of vitriol. At present, the mixture, whose temperature is considerably increased, is placed in a heated sand bath and distilled, without being suffered to cool until one half the quantity of the spirit is come over; meanwhile, an inflammable gas also passes over. If the distillation is continued, sulphurous acid passes over, and a light yellow sweet oil of wine; the black residuary sulphuric acid contains charcoal diffused through it, which may be separated by admixture with water, and filtration. If fresh alkohol is poured on the residuum, more ether may be obtained by distillation. The unrectified ether, as the first product is called, contains both water and alkohol: dry salt of tartar separates the first, and then pouring off the upper liquid, and adding dry muriate of lime in powder, this salt unites with the alkohol, and the ether swims on the solution. Its specific gravity is 0·632 at 60° Fahr.; it holds a little of the muriate, from which it may be separated by distillation, but then its specific gravity is increased. Ether, rectified by distillation, from muriate of lime, had a specific gravity of 0·715 at 68° Fahr.

Ether is limpid, colourless, very fragrant, hot, and pungent to the taste, extremely volatile, and apt to catch fire; at 40° below 0 Fahr. it freezes and forms crystals. It burns with a white flame, and leaves some traces of charcoal. When passed into oxygen gas, or any other air-like body, in a quick-silver trough, it doubles the bulk thereof. When 1 measure of etherized oxygen gas is mixed with 3 of pure oxygen and fired by an electric spark, it explodes, and is changed into 2·5 of carbonic acid, and water equal to one quarter the weight of the other; hence a charge of ether is equal to 5 C + C H + O, or 5 (C H) + H ʹ. So that, in the preparation of ether, 5 charges of alkohol (= 10 C + 15 H + 5 O) seem to be changed into 2 of ether (= 10 C + 12 H + 2 O) and 3 of water (= 3 H + 3 O) by being merely retained by the sulphuric acid, until they attain a certain temperature, at which new combinations take place: while another portion of the alkohol is acted upon by a portion of the sulphuric acid itself, by which there is formed an acid called the sulphovinic, and other products which have not been properly examined. Some consider the sulphovinic acid to be the same with the hyposulphuric, but with the usual illogicalness of chemists, assert in the same sentence, that it differs from that acid by containing an oil.

The Pharmacopœia orders the mixture of spirit and sulphuric acid to be distilled until a heavier liquid than the ether comes over, and lies at the bottom of it; then to mix this impure ether with a small quantity of potasse dissolved in water, and re-distil it. For obtaining the oleum æthereum from the residuum of the first process, after the unrectified ether is taken away, the distillation is continued until a black scum begins to rise, when the retort is immediately withdrawn from the fire; water is then added to this residuum, when the ethereal oil of wine swims on the top, and being drawn off is to be shaken with lime water to separate any acid remaining in it. A mixture of ether with twice its bulk of spirit of wine, is the spiritus ætheris sulphurici; and a mixture of two dram measures of ethereal oil with a pint of spiritus ætheris sulphurici, the spiritus ætheris compositus of the Pharmacopœia.

Ether added to water, takes up a small portion of it, and the water seems to abstract from the ether a substance which may be obtained in crystals by evaporation.

Ether, if perfectly free from alkohol, forms a transparent solution of phosphorus.

Ether abstracts gold from the nitro-muriatic solution.

Olefiant Gas.—Spirit of wine heated with 4 times its weight of sulphuric acid, yields at once carburetted hydrogen gas or olefiant gas, which is usually received over water, although this liquid absorbs a seventh of its bulk. A gallon of this gas weighs about 67 gr.; it burns with a splendid white flame; and is now used for illumination.

Olefiant gas passed through a red hot tube deposits a little charcoal, and measures nearly twice as much as before; a greater heat makes it deposit more charcoal, and increases its bulk; a very high temperature separates nearly the whole of its carbone, and it measures 3·5 its original bulk; electric sparks produce the same effect.

A measure of olefiant gas, mixed with three measures of oxygen gas, and exploded by the electric spark, is changed into water and two measures of carbonic acid gas; whence its composition is C H.

Olefiant gas mixed with an equal measure of chlorine, or oxymuriatic acid gas, over water, is condensed into a limpid distillable oil, burning with a green flame, from which charcoal is deposited, and muriatic acid gas is evolved.

Phosphoric &c. Ether.—Spirit of wine passed through heated phosphoric acid, or arsenic acid, is converted into ether.

Nitric Ether.—Spirit of wine is very violently acted upon by nitric acid, and the products are various, according to the proportion of the acid and the quickness with which it is allowed to act. Three ounces in weight of nitric acid, added gradually to 2 pints of spirit of wine, and 26 ounce measures distilled off, is the spiritus ætheris nitrici of the Pharmacopœia, substituted for the old sweet spirit of nitre. This preparation has a very agreeable smell, and is an excellent stimulant. With a large proportion of acid, an ethereal liquor is produced which may be separated by passing the vapour through several successive portions of a saturated brine of common salt, on which it will float; the acid retained by it, must be separated by shaking it up with powdered chalk. This nitric ether is rather heavier than alkohol, but much more volatile than sulphuric ether; it mixes with 48 times its bulk of water; but is miscible in every proportion with alkohol; when kept for some time, the nitric and acetic acids are developed in it; hence it is probable, that it differs from sulphuric ether by having nitric acid substituted for water in its composition, and that it is $2\,(C\,H) + Az^{5}$ or N^{6}, according to Berzelius. One part of spirit and 3 of acid, sp. gr. 1·261, being distilled together until only one 32dth part remains, much nitrous gas and etherized nitrous gas are disengaged; and on cooling, crystals of an acid, called the oxalic, are formed in the residuum.

Brugnatelli's fulminating Silver.—If 2 oz. measures of spirit of wine is added to a solution of 40 gr. of silver in

2 oz. by weight of nitric acid, or to a solution of 1 dr. Troy of lunar caustic in 2 oz. measures of distilled water, and the mixture boiled in a flask so that the condensed steam may fall back into the boiling liquid, white crystals gradually separate, which being washed with water, and dried between blotting paper, explode with the slightest friction, or by being touched with a glass rod while in the fluid in which they were formed: this is sold by the name of Brugnatelli's fulminating silver.

Muriatic Ether.—Spirit of wine is also changed into an ether by muriatic acid, by distilling an equal measure of each in the purest state; the ether passes over in the state of gas, a gallon of which weighs about 15 grains, and is absorbable by the same bulk of water. At 52° Fahr. it condenses into a limpid liquor or muriatic ether, which is much more volatile than the sulphuric. It does not give out acid when shaken with an alkaline ley, nor produce a precipitate with the nitric solution of silver, but when set on fire it burns with a green flame, and a considerable quantity of muriatic acid in vapour is immediately disengaged. This ether contains, according to Thenard, 29.44 per cent. of muriatic acid, a proportion of acid exceeding that in the strongest spirit of salt.

Vinegar.—Vinegar is obtained in various methods; that usually sold in England is made from malted barley, 32 gallons of which being ground, are infused in hot water so as to strain 100 gallons of wort; to this, when it has cooled down to 75° Fahr. 4 gallons of yeast are added: the liquor is then racked off into casks, having a false bottom, about a foot from the real, on which is put a quantity of rape, that is to say, the remains of the raisins from whence British wines have been manufactured, or even common low-priced raisins; the casks are placed in pairs, the one full, the other half full, and every 24 hours the half-full cask is filled up from the other in turns, until the vinegar is ready for use. Sometimes the vinegar is made without the rape or raisins, and these are added afterwards to give the required flavour. Good vinegar is also made from brown sugar dissolved in water, in the proportion of 18 oz. av. to each gallon, and fermented with yeast and rape. When these vinegars are mixed with an equal quantity of water, and the original quantity of the vinegar drawn off by distillation, it loses its brown colonr, and comes over limpid as water, and is hence called white-wine vinegar, and by the chemists distilled vinegar. The Pharmacopœia, to form its acidum aceticum, orders 8 pints of vinegar to be distilled in a glass vessel, the first pint to be rejected, and the next six saved: unless great care is taken, this is apt to be burnt. Vinegar is also distilled from the hard woods, as oak, ash, birch, or beech, 8 cwt. of which yields about 35 gallons or 300 lb. of deep brown vinegar; the residuary charcoal is about one fifth of the weight of the woods. On re-distilling this vinegar, it leaves in the still one fifth of tar, and becomes clearer; its specific gravity is 1.013, and it is about half as strong again as the best ma't vinegar. By re-distilling it, saturating it with slaked lime, straining the solution, evaporating it to dryness, adding a sufficient quantity of sulphuric acid to saturate the lime, and again distilling it, a colourless vinegar is obtained without any burnt smell or taste, and considerably stronger than the common distilled vinegar.

Acetic acid, when pure, was not altered by distillation; even when the vapour was passed several times through a red-hot earthen tube, only part was destroyed, and a considerable portion merely turned brown: when indeed the tube was filled with charcoal, a single distillation reduced the acid to water, carbonic acid gas, and carburetted hydrogen. Berzelius considers the acetic acid to consist of $4\ C + 3\ H + 3\ O$: hence a charge of it is to a charge of oxygen as 6.375 to 1.

Distilled vinegar, or acetic acid, saturated with purified pearl ash, then evaporated to an half, strained through fresh burnt bone black, and afterwards evaporated to a proper degree, yields by cooling a salt in fine white plates, formerly called terra foliata tartari, from its appearance and the salt of tartar being then commonly used instead of purified pearl ash: it is the potassæ acetas of the present Pharmacopœia. This salt has a sharp warm taste, is soluble in its own weight of water, and runs soon into a liquid by exposure to the air; it is also soluble in spirit of wine. By distillation it yields carbonic acid, carburetted hydrogen, acetic acid diluted with water, and a large proportion of a peculiar inflammable liquor, called pyro-acetic spirit, which is miscible in every proportion with water or spirit of wine. From this salt, rendered as dry as possible by fusion, and distilled with half its weight of oil of vitriol, the strongest acetic acid is procured, which is extremely pungent to the nostrils, and excoriates the skin: at 50° Fahr. it crystallizes in oblong plates.

Acetic acid, saturated with the carbonate of ammonia, called volatile sal ammoniac, of which it generally requires an ounce to a pint, is the liquor ammoniæ acetatis of the Pharmacopœia, but was formerly called Mindererus's spirit, from the physician who introduced it into general practice.

Acetic acid, boiled on about one quarter its weight of litharge to three quarters its bulk, then set by to settle, and poured off clear, is the liquor plumbi acetatis of the Pharmacopœia, a dram of which added to a pint of water, and a dram measure of proof spirit, forms the well-known Goulard's lotion. These are solutions of a salt which may be crystallized in plates, and is a subtritacetate of lead, or acet. ac. + 3 ox. lead.

Acetic acid, boiled on about one twelfth of its weight of white lead, or litharge, the solution filtered, evaporated to a pellicle and set by, crystallizes in small satiny crystals, of a rather astringent but sweet taste, and hence usually called sugar of lead, the acetate of lead of modern theorists, and the plumbi superacetas of the Pharmacopœia. Its specific gravity is 2·345; it is soluble in between three and four times its weight of water, the carbonic acid usually contained in which unites with part of the lead, and falls down in a white powder. The crystals are composed of acet. ac. + ox. lead + 3 water. On distillation without addition they afford acetic acid mixed with pyro-acetic spirit. When distilled with one fourth of their weight of oil of vitriol, or two fifths of their weight of calcined green vitriol, they afford a strong acetic acid, rather weaker than that from acetate of potasse.

The sweetness communicated by lead to sour wine, in consequence of the formation of this salt, has led the wine coopers to use this metal to disguise the sourness; but lead, even in a very small quantity, produces palsy, and without giving any warning; and hence this practice should be severely punished.

Vinegar is used to preserve several kinds of vegetables; and as a green colour is considered desirable, the housewives frequently put in a piece of copper to improve the colour: there is not that danger in this practice as some authors pretend, for copper has no insidious action on the human body like lead; and if too much copper was employed, its emetic quality would immediately give the alarm, and consign the pickles to the dusthole.

Earthy and absorbent Bodies.—Only one compound combustible substance of this kind is now quoted in the London Pharmacopœia, namely, testæ.

Testæ.—Oyster shells consist of carbonate of lime deposited in a tissue of gelatinous matter, which latter is very small in quantity; hence they are used only as antacids. On calcination, the gelatinous matter is burned, the carbonic acid is driven off, and a pure lime remains.

Absorbent bodies are used when an acid seems to abound in the body, especially in sedentary persons, or in old men, and females: they are also useful in hypochondriacal diseases, in fits arising in children as springing from acidity in the first passages, and in canine appetite. Externally, from their porosity, they imbibe moisture quickly, and hence dry up ulcers without healing them; and in other cases, by absorbing the superfluous moisture, they prevent the putrefaction of ichorous and sanious ulcers. The state of the stomach sometimes causes these bodies to act as laxatives, by their forming a purging salt with the acid in the stomach; and at other times they bind the bowels and stop all other fluxes.

Farinaceous &c. Bodies.—The bodies of this kind which are mentioned in the Pharmacopœia are more numerous, namely, acaciæ gummi, althææ folia, althææ radix, amylum, avenæ semina, cera alba, cera flava, cornua, cydoniæ semina, farina, ficus, fucus, hordeum, hyoscyami folia, lichen, lini usitatissimi semina, malva, ovum, rhæados petala, sambuci flores, sarsaparillæ radix, and tragacantha, of which in order.

Acaciæ Gummi.—Gum Arabic is soluble in water, but insoluble in spirit of wine. The mucilago acaciæ of the Pharmacopœia is made with two waters: a thinner mucilage with burnt hartshorn is also ordered by the name of mistura cornu usti, which is only phosphate of lime held in suspension; the requisite thickness was originally given by crust of bread, and the decoction flavoured by cinnamon and sugar, or syrup of orange juice; the burnt hartshorn was then only put in for colour, instead of being as at present the useless apparent basis of the medicine, as phosphate of lime can have no antacid powers. 480 gr. of gum, digested with 2880 gr. of nitric acid, yielded 210 gr. of a crystallizable acid, now called the mucic, but formerly the saclactic, and

6 gr. of oxalate of lime. It contains about 61·4 per cent. of oxygen; 33·4 of carbone; 5·1 of hydrogen: whence it is supposed to be 6 C + 5 H + 8 O, or rather $(6C+5H)^8$.

Althææ Folia et Radix.—Marsh mallow leaves and root both contain much mucus, which is taken up by water when boiled in it: this mucus differs from the solution of gum Arabic, as it is not precipitated when a solution of silica in potasse is poured into it.

Amylum.—Starch is a pulverulent substance obtained generally from wheat, by steeping the grain in water until it yields a milky juice on being squeezed: it is then enclosed in bags and pressed in water, from which, on standing some time, the starch is deposited. Starch is insoluble in cold water, spirit of wine, or ether; but soluble in hot water: 3 drams to a pint of water forms the mucilago amyli of the Pharmacopœia. A finer kind of starch, obtained generally from potatoes, is sold under the name of arrow root, which is much easier dissolved in boiling water. The mucilage of starch speedily grows sour, and becomes covered with fungi.

Avenæ Semina.—Grits have not been examined by the chemists: boiled with water and strained, they form a nutritive gruel, as they contain nearly half their weight of starch.

Cera flava.—Bees' wax is obtained from the hives of these insects, after the honey has been drained from the combs, and the remaining honey has been extracted by the combs being boiled in water. Its specific gravity is about 0·96, it melts at 142° Fahr. and burns without leaving any residue, when sufficiently heated. It is taken up in small proportion by hot spirit of wine or ether, but is deposited again on cooling.

Cera alba.—White wax is obtained from bees' wax, by bleaching either in the sun's rays, the bleaching being assisted by watering, to carry off the altered colouring matter, or effected by the oxymuriatic acid. It is only used, in ointments, for its colour. Its specific gravity is 0·82 to 0·96; it melts at 155° Fahr. With a wick it burns without any residuum.

Cornua.—Stags or harts horns are those ordered by the College; but as these are brown internally, they are left to the cutlers, and deers horns are the only sort that are cut into shavings for the apothecaries. Hartshorn shavings, as they are called, when boiled in water, and the decoction strained, furnish a clear gelatinous mass, which may be melted by a very gentle heat: they contain in 100 parts, 27 of gelatine and 73 of phosphate of lime. Horns were formerly distilled, the alkaline liquor yielded by them being the pleasantest in smell of any obtained from organized bodies by distillation, and the solution of the carbonate of ammonia in water is still called spirit of hartshorn: this being now made from sal ammoniac, the horns are burned in an open pot for burnt hartshorn.

Hartshorn shavings, calcined with half their weight of sulphuret of antimony to whiteness, is the pulvis antimonialis of the last edition of the Pharmacopœia, and the James's powder of the nostrum mongers. The old edition ordered equal parts, which produced a powder different from the popular nostrum. This is supposed to be a lime-phosphate of antimony.

Horns of any kind, or even any other animal matter, as dried blood, being mixed and heated with an equal quantity of salt of tartar, until the mass acquires the consistence of paste, and then cooled, affords, when eight times its weight of water is poured on it, a yellowish solution of hydro-cyanate of potasse. This solution being filtered and mixed with a solution of two parts of alum and one of green vitriol, produces a dingy green sediment, which on being well washed with dilute spirit of salt, becomes of a fine blue colour, and is called in the shops Prussian blue, and by theorists hydro-cyanate of iron, as being supposed to be a compound of red oxide of iron with an acid called the hydro-cyanic, which they conceive to be itself a composition of two charges of carbone with one of nitrogen, formed into an acid by an additional charge of hydrogen, or $(2\,C+N)\,H + Ir^3$ but some conceive the hydrogen to be merely a part of the water from which the blue cannot be freed by the most careful drying without decomposition.

Prussian Blue.—Prussian blue, added to a solution of potasse in water until its colour is no longer altered, is changed into oxide of iron; the supernatant liquor being filtered and evaporated yields yellow table-like crystals, called by some triple prussiate of potasse, as being a compound of prussic acid with potasse and oxide of iron, and by others the ferro-cyanate of potasse.

Prussian blue, boiled in water along with ammonia, soda, lime, magnesia, barytes, or strontia, yields the ferro-cyanates of those bases. The ferro-cyanate of barytes being dissolved in water, and the barytes precipitated by dropping in oil of vitriol, yields a pale yellow acid, called the ferro-cyanic acid or ferro-chyazic acid; it is esteemed $= (2\,C + N) + Ir^3$: this has no smell, and when exposed to a gentle heat or strong light, lets fall a white hydro-cyanate of iron, which becomes blue in the light, and the remainder is changed into hydro-cyanic acid, called also prussic acid, and esteemed as already mentioned, $= (2\,C + N) + H$.

Prussian blue, boiled with half its weight of red oxide of quick silver, and 3 or 4 times its weight of water, yields a solution from whence crystals of cyanide of quick silver, according to one theory, or prussiate of quick silver, according to another, may be obtained.

Prussian blue, distilled with half its weight each of oil of vitriol and water previously mixed, yields also prussic or hydrocyanic acid.

Prussiate of Quick Silver.—Prussiate of quick silver, when dry and pure, being heated, emits an inflammable gas of a peculiar penetrating smell, which is absorbed by water. On being detonated with twice its measure of oxygen gas, they are changed into 2 measures of carbonic acid gas mixed with 1 measure of azotè: so that the cyanogen, as the gas is called, is composed of $2\,C + N$, as on being detonated with $4\,O$ it forms $2\,C^2 + N$.

Prussiate of quick silver distilled with spirit of salt, rather less in quantity than would be sufficient to dissolve the oxide of quick silver contained in the prussiate, and the vapours passed through a tube partly filled with pieces of marble to absorb any muriatic acid that may pass over, and partly with muriate (chloride), of lime to absorb the watery vapours, yields by a moderate heat prussic acid, which attaches itself to the marble, but by applying a very gentle heat it may be driven from it, and finally condensed in the receiver, which should be surrounded with pounded ice or snow. The pure prussic acid thus obtained is one of the most violent poisons yet known. When a rod dipped in it is put on the tongue of an animal, death instantly ensues. By mixing one part of it with eight parts and an half by weight of water, it forms the medicinal prussic acid of Magendie. A dram of this being mixed with a pint of distilled water and an ounce and half of sugar, forms a mixture, of which a table spoonful, taken morning and evening, is now recommended in phthisis; instead of the lauro-cerasus, or black cherry water, formerly used.

Prussiate of quick silver, dissolved in twice its weight of water, and a solution of sulphuret of barytes in water added as long as the dark precipitate of sulphuret of quick silver falls down, then washing this sulphuret of quick silver with a little water, so that eight times the weight of the prussiate of quick silver may pass the filtre, yields a solution of prussiate of barytes, with a slight adulteration of sulphuret of barytes. Oil of vitriol, previously mixed with an equal weight of water, being added to this liquor as long as sulphate of barytes is thrown down, the sulphuretted hydrogen that remains then removed by shaking it with white lead, and the liquor afterwards passed through a covered filtre, yields prussic acid of the medicinal strength.

Cydoniæ Semina.—Quince seeds boiled for a short time in water, yield much mucus, which soon spoils. The mucus probably contains some astringent and other substances, but is not altered in colour by green vitriol.

Farina.—Wheat flour made into a stiff paste with a little cold water, and then kneaded in cold water until it no longer discolours it, leaves in the hand an extensible grayish mass somewhat like Indian rubber, called gluten, which contains azote and yields ammonia by distillation. This gluten kneaded in spirit of wine, part is taken up and may be obtained by evaporation; this is called gliadine: another part of the gluten remains, and is called zimome. The water used for washing the flour deposits by settling a whitish powder, soluble in boiling water, called starch, the upper part of which is discoloured, and the water retains in solution a very little of the gluten, with some sugar, mucilage, and phosphate of lime. The flour mixed with water into a thin fluid and boiled, forms common paste, much used as a cement: some alum is frequently added to render it unpalatable to insects; corrosive sublimate has been proposed for the same purpose, and to prevent fermentation.

Fucus.—Bladder wrack on drying is frequently covered with a saline efflorescence. When burnt it yields charcoal, containing carbonate of soda, as also iodine.

Hordei Semina.—Pearl barley consists almost entirely of starch, with some gluten, mucilage, and saccharine matter; the decoction does not so soon become sour as that of grits.

Hyoscyami Folia.—Hen-bane leaves when dry have little smell or taste; the watery infusion is tasteless, but has a narcotic odour; it is turned from a very pale yellow to a pale olive by green vitriol, a dark sediment being slowly deposited. The fresh leaves bruised, moistened, pressed, and the juice evaporated without being strained, yield a fetid extract, of a bitterish saline taste, of a narcotic quality. Spirit of wine diluted extracts all its virtues. This tincture is in the Pharmacopœia, and is used as a narcotic.

Hyoscyami Semina.—Hen-bane seeds have the same narcotic power as the leaves, but have not been examined chemically, except by distillation: they yield an oil of a faint smell.

Lichen.—Iceland moss, which has lately been substituted for the tree lung-wort of our forefathers, contains, according to Proust, one third of starch, and two thirds of a substance insoluble in hot water, resembling the gluten of wheat, with a small quantity of a bitter extractive matter: the infusion is turned red by green vitriol.

Lini usitatissimi Semina.—Lint seeds yield by expression about one sixth of their weight of oil, which does not freeze, but soon becomes rancid. By infusion they yield a colourless mucilage, slightly different from gum Arabic.

Malva.—Mallow by decoction yields much mucilage, to which it owes its demulcent qualities.

Ovum.—White of egg is composed of 85 per cent. of water; the remainder is albumen with traces of an uncoagulable matter and salts, sulphuretted hydrogen, and benzoic acid: 100 parts, exposed in the receiver of an air-pump, with a vessel of oil of vitriol to absorb the water, the dried mass weighed 13·65, was transparent, and recovered its original viscid appearance by soaking in water. It coagulates by a heat of 165° Fahr. as also by acids; the coagulum is not soluble either in cold or hot water.

Yelk of egg, agitated with water, forms an emulsion; on being boiled hard, it becomes granular, and yields an oil by expression.

Rhœados Petala.—Red poppy flowers have a mucilaginous taste, with a very slight bitterness, but they have not been chemically examined. They are now used only for the red colour they communicate to water; although, from their faint narcotic odour, they have been considered as anodyne by some.

Sambuci Flores.—Elder flowers have a mucilaginous bitterish taste, and a faint smell, both of which are communicated to water either by infusion or distillation. In distillation with water they yield a very small quantity of butter like oil.

Sarsaparillæ Radix.—Sarsaparilla root has a slimy mucilaginous taste, with very little bitterness, but no smell. The infusion is brown, and by standing deposits a white starch; reddens litmus paper, and yields a precipitate with lime water, or nitrate of quick silver, but not with green vitriol. The decoction evaporated yields an extract. There are several kinds of sarsa in the market, and it is very offensive to prepare an extract from one sort, the fœtor it diffuses being almost insupportable, and remaining several days.

Tragacanthæ Gummi.—Gum tragacanth is slightly bitter; it is difficultly soluble in water, swelling very much and softening therein, but requiring rubbing to diffuse it, and on standing much of the mucilage subsides, leaving a thinner portion at the top containing very little of the gum. The admixture of gum Arabic hastens this separation. From its slimy nature, it is chiefly used in forming lozenges. The mucilage yields a precipitate on the addition of oxymuriate of tin, but not by liquor of flints, nor the red sulphate of iron. Gum tragacanth is not soluble in spirit of wine: it burns with a blue flame. Cherry-tree gum is of the same nature as gum tragacanth, and the pure chemists call their common principle cerasine, and lately prunine.

Flesh and Blood.—The various species of flesh, as beef, veal, &c. and also fish, as cod, &c. dried by means of oil of vitriol in the receiver of an air-pump, as mentioned under the article Lime water, lost from 71 to 82 per cent. of water; the dried mass boiled in water yielded to it from 5 to 7 per cent. (of the original weight) of gelatine or glue, and there was from 13 to 20 of albumen or fibrine left undissolved. The various proportions seemed to have no reference to their digestibility.

Gelatine, in the purest state, or as it exists in isinglass, contains 48 per cent. of carbone, 27 oxygen, 8 hydrogen, and 17 of azote; perhaps 15 C + 6 O + 14 H + 2 Az.

Albumen contains 53 per cent. of carbone, 24 oxygen, 7 hydrogen, and 16 azote; perhaps 17 C + 6 O + 13 H + 2 Az.: but Dr. Prout thinks the composition is as above stated for gelatine; and indeed these very compound bodies are so difficult to analyze, that little or no dependence can be placed upon the results that have yet been published.

Most of the mild animal fluids are probably of the same nature as flesh, only containing a larger proportion of water.

Blood also holds albumen and fibrine (which last differs from albumen and gelatine in not being soluble either in cold or boiling water), along with a colouring matter which has been supposed to be albumen coloured with oxide of iron, but the very small quantity of iron obtainable from it does not seem sufficient for that purpose.

Farinaceous and slimy substances sheath the acrimony of the secretions, nourish and supple the solids, promote suppuration, and sometimes discuss and cleanse ulcers; hence they are particularly useful in coughs, catarrhs, spitting of blood, hectic fever, phthisis, as also in difficulty and heat of urine, in bloody urine, ulcers of the bladder, dysentery, and the like diseases.

Bitters.—The third division of compound combustibles is composed of the bitters, which may be subdivided into pure bitters, and those which are aromatic, astringent, or sweet.

The purer bitters of the materia medica are, absinthium, aloes spicatæ extractum, aloes vulgaris extractum, amygdalæ amaræ, centaurii cacumina, colocynthidis pulpa, gentianæ radix, menyanthes, quassiæ lignum, simaroubæ cortex, spartii cacumina, and taraxaci radix.

Absinthium.—Common wormwood is intensely bitter, with a slight pungency and extreme nauseousness: its smell is very disagreeable. Distilled with water, it affords a dark green essential oil, ʒvj to x from ℔xxv. The infusion is pale olive, and rendered black as ink by both green and white vitriol. It is said to have yielded to water 66 per cent. of a vegetable acid combined with potasse, 15·4 of uncombined acid, 3·7 of muriate of potasse, and 14·8 of rosin: the ashes of the residuum were principally carbonate of lime. It gives out its virtues to spirit of wine. When burned it yields a large proportion of carbonate of potasse.

Aloes spicatæ Extractum.—Socotrine or Turkey aloes, as it is called, has an intense and permanent bitter taste, and a peculiar aromatic odour, like a decaying russet apple: the powder is a bright golden yellow. The Socotrine aloes forms a limpid solution in spirit of wine, and without leaving any residue. When distilled with water it yields a volatile oil: it is nearly totally soluble in boiling water, but as it cools a peculiar bitter matter of a resinous nature is deposited; on continuing the boiling, the extractive matter taken up is rendered insoluble and separated. The apothecaries usually employ for this the Cape aloes, which is said to be prepared from the same plant, but the expressed juice is evaporated without being let to deposit its feculencies, as is the case with the Socotrine. The Cape aloes, when powdered, is of a greenish yellow, and it has a stronger odour than the Socotrine.

Aloes vulgaris Extractum.—Hepatic or Bombay aloes is duller and browner than the Socotrine; but, in other respects, resembles the latter. The Barbadoes aloes is usually substituted for it, whose taste and smell is nauseous, and the powder a dull greenish yellow: it does not yield an essential oil by distillation with water; nor is it totally soluble in spirit of wine.

There is also a still more fetid aloes, called aloes caballina, or horse aloes.

Amygdalæ amaræ.—Bitter almonds are a variety of the sweet almond; they consist of faricaneous matter, and one fourth their weight of a very fine mild oil, which is scentless if drawn cold. The bitter substance remains in the cake; it may be dissolved by digestion of the almonds or their cake in water, and is also carried over in distillation with water: it is either prussic acid or combined with that acid. The distilled water was sold under the name of black cherry water, much used formerly as an antispasmodic and calming medicine, but discarded some years ago, when the apothecaries began to practise independently of physicians, and all powerful medicines were discouraged, as too dangerous to be meddled with by them, considering the mode in which they acquire their knowledge; merely by serving an apprenticeship during their boyhood, and then, after a hasty attendance on a few lectures, commencing practice at a very early age, and thus acquiring a habit of treating diseases by routine, rather than on any general principles: the exceptions to this mode being few. But these fears have subsided, and this medicine, when made of a proper strength, will probably again be revived, and used for prussic acid.

A volatile oil is also obtained from bitter almonds by distillation with water: an operation which is very disagreeable unless the vessels are well luted, the fumes occasioning violent head ach, nausea, and cough. The oil is pale yellow, with the smell of peach blossoms. It contains prussic acid, as is evident by its instantly killing animals, when a few drops are placed on their tongue. Diluted with seven times as much spirit of wine, it is used in confectionery under the name of essence of bitter almonds.

Centaurii Cacumina.—Centory tops yield to water an infusion resembling common tea, turning brown with green vitriol. The extract, by means of water, is by some quoted as two thirds their weight, by others only two ninths; that by means of spirit of wine, a seventh part.

Colocynthidis Pulpa.—Coloquintida pulp is extremely bitter, nauseous, and rather acrid; its decoction is reddish, and very bitter, and by long boiling becomes gelatinous, so as scarcely to pass the strainer. 8 oz. yielded 3 of extract, purging more mildly than the pulp: spirit of wine extracts only one sixteenth. The ground coloquintida is usually made from the seeds as well as the pulp, and, of course, weaker.

Gentianæ Radix.—Gentian root is very bitter; the infusion is red, scentless, very bitter, turning slightly brown with green vitriol; it yields, by water, three eighths of bitter extract, not alkaline, and by spirit of wine, one fourth of resinous extract. The Tyrolese distil an ardent spirit from this root. Besides bitter matter, gentian root contains a matter very like bird lime, a resinous or alkaline matter, to which its smell is owing, gum united with colouring matter, and phosphate of lime; but neither inuline nor starch.

Menyanthes.—Bog bean yields by expression 3 quarters its weight of juice, from whence a green sediment, composed of 3 parts of albumen and 1 of rosin, falls down; the clear liquor contains malic acid, acetate of potasse, a peculiar matter, a bitter extractive matter, a brown gum, and a quantity of inuline. The infusion is very bitter and grows black with green vitriol; lb. viij yielded ℥vj of extract. The spirituous tincture is excessively bitter.

Quassiæ Lignum.—Quassia wood, by cold infusion for a couple of days, gave a colourless liquor, extremely bitter; by warm infusion the liquor was pale yellow, but not much more bitter; the decoction is neither deeper coloured nor more bitter than the infusion in warm water; the spirituous tincture is yellowish, and very bitter; none of them were altered by green vitriol. 14 oz. yielded, by water, 1·5 of a brown, very bitter extract: it seems a peculiar substance, the solution of which does not alter litmus; it yields a precipitate with nitrate of silver, but not with nitrate of lead, nor scarcely any other test hitherto mentioned; it is similar to the bitter matter of coloquintida, and is also contained in wheat. Spirit of wine extracts only one sixth.

Simaroubæ Cortex.—Mountain damson bark is bitter and rather astringent; the weak infusion is like tea, but bitter, and not changed by green vitriol. The decoction is not milky; it yields a quarter of extract; the tincture is bitter; only a fortieth of the bark is taken up.

Spartii Cacumina.—Broom tops, when bruised, emit a disagreeable odour; they are nauseously bitter, and communicate the same taste to water.

Taraxaci Radix.—Dandelion, or piss-a-bed root, has a bitter, yet sweetish, and acid taste. The expressed juice is whitish, reddens litmus, and is thought to contain tartaric acid. The decoction yields a precipitate with nitrate of silver, and solution of corrosive sublimate.

Aromatic Bitters.—The aromatic bitters of the Pharmacopœia are anthemidis flores, calami radix, cascarillæ cortex, cuspariæ cortex, lauri folia, limonum cortex, marrubium, and myrrha.

Anthemidis Flores.—Camomile flowers have a bitterish warm taste; the infusion is yellowish, fragrant, warm, bitter, becoming brown with green vitriol; it loses its odour by boiling, so that the extract is bitter, saline, with very little smell. Distilled water, fragrant; essential oil, generally yellowish, inclining to green, sometimes blue, tasting and smelling like the plant; 82 lb. yielded 13 drams, of a blue colour; another similar parcel of flowers distilled with camomile instead of plain water, yielded 18 drams. Spirit of wine extracts its virtues better than water.

Calami Radix.—Sweet flag root is warm, sharp, nauseous, and slightly bitter; the fresh root is the warmest. The infusion is thin, limpid, slightly mucilaginous, having the smell of the root, tasting at first sweet, afterwards bitterish, rather sharp, nauseous; green vitriol renders it glutinous and whitish. Essential oil, brownish.

Cascarillæ Cortex.—Cascarilla bark is warm and bitterish, the bitterness increasing as it is chewed, and very lasting. It takes fire easily, and burns vividly, but when taken from the fire or candle it goes out, and emits a grateful smoke, like that of amber. Infusion reddish, fragrant, bitterish, growing brown with green vitriol; essential oil, 1 lb. from 30 of bark; watery extract, 3 drams from 4 ounces. Tromsdorff found it contained 18 per cent. of mucilage and bitter principle, 15 of resin, 1·5 of volatile oil, 1 of water, and 64·5 of woody fibre. The tincture is very bitter, and yields an eighth of resin.

Cuspariæ Cortex.—Angustura bark is bitter, slightly warm, and leaves a pungent heat in the mouth; when rubbed with lime or magnesia, it gives the smell of ammonia. The infusion affords a yellow precipitate with green vitriol, blue vitriol, corrosive sublimate, and potasse water, as also with nitrate of silver; but this latter sediment becomes violet blue: the colour only of the infusion is deepened by spirit of sal ammoniac. Oil of vitriol changes the infusion brown, and a lemon yellow sediment is slowly deposited; nitric acid turns it blood red, and a lemon colour sediment falls down after some time; spirit of salt does not affect it. Essential oil very small in quantity and white.

Lauri Folia.—Bay leaves are fragrant; the infusion is red, and becomes purplish with green vitriol; the essential oil is limpid, aromatic, and lighter than water.

Limonum Cortex.—Lemon peel is but slightly bitter; it gives out its essential oil either by expression, or distillation with water.

Marrubium.—Horehound is fragrant and bitter; the infusion is red and bitter, it grows brown with green vitriol; it yields 5 parts in 16 of extract.

Myrrha.—Myrrh is fragrant, and bitter; when chewed, it is first brittle, but afterwards sticks to the teeth, rendering the saliva milky. In the flame of a candle it takes fire, does not drop, and burns with a high, smoking, very brilliant flame. In an iron ladle it does not melt, but remains solid, sweats, and is changed into a coal, without taking fire; but if a flame is brought near it while sweating it takes fire, and leaves a blackish coal. The greater part is dissolved in hot water, but on cooling, the rosin falls down; the latter part is dissolved in spirit of wine. The tincture is reddish, bitter, odour slight; if water is added, the tincture turns white, and smells stronger of myrrh. Distilled with water, it yields a 64th part of a fragrant, heavy oil, and a scented distilled water. During powdering it provokes sneezing.

Valerianæ Radix.—The only fetid bitter is valerian root, whose infusion is deep red, and turns black with green vitriol. It does not provoke sneezing while it is powdered. 6 lb. of the dry root produced 2 lb. 5 oz. of a bitterish extract, having a heavy smell: the distilled water is fragrant, but very little oil comes over. The oil is greenish white, very liquid, having the taste and smell of camphire; it is lighter than water; nitric acid, if in sufficient proportion, converts it into oxalic acid. The London College order a tincture of ℥ij of the root, to a pint of proof spirit.

Astringent Bitters.—The astringent bitters are the various kinds of barks, as they are called by way of eminence: the gray, or Peruvian bark, the yellow, and the red.

Cinchonæ lancifoliæ Cortex.—Ordinary Peruvian bark yields a cinnamon-coloured powder, and a pale yellow infusion, having the colour and smell of bark. This infusion reddens litmus paper, and forms a precipitate with a solution of sugar of lead, but not with green vitriol, being only changed olive green. The decoction is deeper coloured, and a yellow sediment is deposited. Spirit of wine acquires a deep orange colour; this tincture is precipitated by green vitriol, and rendered thick with a reddish sediment merely by water. Ether acquires a golden yellow colour; the ethereal tincture reddens litmus paper, and when poured upon water, communicated its own colour, the flavour of the infusion; and the water yielded a precipitate with green vitriol; the ether, on evaporating from the water, leaves a skin of bitter rosin on the surface. The extract by decoction, is about one third of the raw bark, is austere, and inferior in virtue to the powder: the extract by infusion is superior to any other preparation; and the residuum, being afterwards boiled in water and made into an extract, affords very little, and that insipid, and not soluble in spirit of wine. An extract, or, as it was called, the essential salt of bark, by infusion in cold water and spontaneous evaporation, has been prepared, but it has no superiority over that by warm infusion. The extract made by spirit of wine is about one fifth. Water acidulated with sulphuric acid boiled upon bark, the decoction strained, and powdered lime added until the liquor has become alkaline and of a dark brown colour, yields a reddish brown sediment. This sediment, being washed, dried, and digested in spirit of wine, and the strained tincture distilled, leaves a brown viscid substance, covered with a bitter, alkaline, and milk-like liquor, which are to be separated. Both contain quina. If the alkaline liquor is saturated with sulphuric acid, and the solution clarified with charcoal, it yields crystals of sulphate of quina; similar crystals are obtainable by boiling the brown substance in water, acidulated with oil of vitriol, and then evaporating the liquid to a proper point. A lb. of bark yields about 3 drams of this sulphate, 8 gr. of which are at present esteemed equal to an ounce of bark.

Cinchonæ cordifoliæ Cortex.—Yellow bark yields a fine orange powder, it is more bitter than the pale bark, but less austere, and does not constringe the tongue when chewed. The infusion is pale yellow, slightly reddish, with a bright yellow sediment; the clear liquor yields a precipitate with sugar of lead, and by degrees, with green vitriol, but at first it is only turned blueish green. Its habits with spirit of wine are the same as those of Peruvian bark. The ethereal tincture is also similar, but does not colour water so deeply as that of the common bark. When macerated in cold water, and the liquor reduced by spontaneous evaporation, it yields about 7 per cent. of crystals of a salt called kinate of lime, which differs from other salts of lime by being soluble in only 5 times its weight of water.

Cinchonæ oblongifoliæ Cortex.—Red bark yields a reddish brown powder, of a slight bitter taste and very astringent. Its infusion reddens vegetable blue colours. The saturated decoction is reddish orange colour, and yields rather more than 6 per cent. of extract: the residual bark then colours spirit of wine red, and yields about 4 per cent. of a red extract, not entirely resinous. The decoction strikes a black colour with green vitriol.

Concerning the names now given by the College to these barks, it may be remarked in general, that it seems absurd to change well-established names, taken from sensible qualities, and to adopt those of another science which has long expired beneath the burden of its own nomenclature, even supposing it were possible for the apothecary to observe the living plants, which is not the case.

Dulcamaræ Caules.—Only one sweet bitter is enumerated as a drug, namely, the stalks of bitter sweet. The infusion of the dried stalks is reddish, intensely bitter, and turns rather brownish by green vitriol; the extract is bitter.

Bitters, in general, do not rise in distillation; they act contrary to acids, as they cool the body; but they seem to unite with them and form a compound that excites the intestinal motion. Bitters increase the appetite, and are serviceable in a deficiency of bile. They are also contrary to sweets, as, instead of nourishing, they seem to attenuate the body. Bitters are supposed to promote the digestion of vegetable food, and to be as necessary in that respect, as common salt is to an animal or mixed diet.

Astringents.—The fourth division of compound combustibles is composed of the austere and acerb substances, and is subdivided into three subdivisions: 1. The strong astringents; 2. those that are of a weaker nature; and 3. an astringent which has some degree of sweetness conjoined with it. The astringents of the first class, enumerated in the College Pharmacopœia, are bistortæ radix, catechu extractum, gallæ, granati cortex, hæmatoxyli lignum, kino, pterocarpi lignum, quercûs cortex, rosæ Gallicæ petala, salicis cortex, tussilago, tormentillæ radix, uvæ ursi folia, and ulmi cortex.

Bistortæ Radix.—Bistort, or snake weed root, has a dry, styptic taste; the infusion is pale yellowish red, very styptic and austere; green vitriol strikes it black immediately, and salt of tartar renders it thick. The saturated decoction is brownish red, opaque, and changes a large proportion of a solution of green vitriol to a violet colour.

Catechu Extractum.—Cutch, or Japan earth, varies in colour, and slightly in composition: the dark sort, which is the most usual, is rather styptic, bitterish, leaving a slight sweetness; soluble in water, leaving about 7·25 per cent. of earthy impurities; the solution is reddish, and yields a black precipitate with green vitriol. If the catechu is washed with successive portions of water, the latter solutions differ from the former; the first containing the chemical principles denominated tannin and mucilage, the latter that called extractive. When all these are extracted from the cutch, the remaining extractive is red, very slightly astringent and rather sweetish. Japan earth is also soluble in vinegar. It does not take fire at a candle, but burns away with a not ungrateful smell. It softens when heated, and then takes fire from a flaming body; the flame is small and yellowish, the remaining coal is spongy, dry, shining, and scarcely dirties the fingers. The dark Japan earth contains 54·5 per cent. of tannic acid, 34 of extractive, 6·5 of mucilage, and 5 of earthy impurity: the light coloured contains a less proportion of tannic acid.

Gallæ.—Nut galls are extremely bitter and styptic, strongly constringing the mouth when chewed; upon being powdered, they provoke sneezing. The saturated infusion is olive green, rather thick, very styptic, becomes black immediately with green vitriol; a single drop, added to an ounce of water, strikes a blackish blue colour immediately on adding green vitriol. This black colour, the precipitation being hindered by the addition of gum Arabic, is the common black ink of the writers. The saturated decoction is still more styptic, without smell, but striking a much deeper black colour with green vitriol. They yield seven eighths of extract by water, and 3 qrs. by spirit of wine. Nut galls, carefully distilled, yield first brilliant crystals of gallic acid: similar crystals may also be obtained by the spontaneous evaporation of the infusion, the acid being equal to a fifth part of the weight of the nut galls; the crystals from the infusion required to be purified by solution in water, boiling with ivory black, to render them white, and recrystallization. This acid can scarcely be obtained free from tannin; is supposed to be composed of $6\,C + 3$ (or 4) $H + 3\,O$.

Tannin.—The tannin of nut galls is generally considered the type of that principle, and various modes have been proposed to obtain it in a state of purity. The best seems to be the extraction of all the soluble part of nut galls by repeated macerations in warm water until they no longer colour the water, the evaporation of these solutions until they are quite thick, straining through linen to separate the extractive, further evaporation to dryness, and digestion with the purest alkohol to separate the gallic acid. If required to be still purer, it must be dissolved in water, and left for some time in a warm place, that the mucilage may produce mouldiness, and thus be separated by filtration: the sulphate of lime, which is still present, is separable by dropping into the solution oil of tartar, separating the precipitate, adding to the liquor sugar of lead, the oxide of which combines with the tannin, and is precipitated. If this precipitate is washed, dried, diffused through water, and sulphuretted hydrogen gas passed through the water, the sulphur separates the lead, and combining with it, is precipitated, while the tannin of nut galls, reduced to its utmost state of purity, dissolves in the water, from whence it may be obtained by filtration and evaporation to dryness. Pure tannin thus procured, is brown, brittle, breaking like rosin, bitter, astringent, soluble in both cold and hot water, and the solution neither grows mouldy nor is changed by keeping. It is not soluble in the purest alkohol, but a very small proportion of water renders spirit of wine capable of dissolving the tannin. The watery solution of tannin does not change the solution of green vitriol, but it produces a deep blue precipitate with the red sulphate of iron. It forms a firm brown precipitate with a solution of isinglass (usually made for that purpose with 6 gr. to the oz. of water): this precipitation is reciprocally employed as a test of the presence of gelatine in animal fluids, or of tannin in vegetable substances.

Granati Cortex.—Pomegranate rind is very styptic to the taste; its infusion is deep red, thick, glutinous, coagulating into a fine red jelly on adding spirit of wine; it grows black, and also glutinous, with green vitriol.

Hæmatoxyli Lignum.—Logwood has a sweetish bitter taste, but styptic: the infusion is a deep brownish red, with a rather pleasant weak smell, strikes black instantly with green vitriol, and much improves the durability of common ink. When fresh, it does not form a precipitate with isinglass, but after keeping some time it does. Sulphuric acid dilutes the colour, and on saturating the acid with salt of tartar, it becomes dark violet, but on dilution soon changes to an aurora colour: nearly the same change takes place if salt of tartar is added to the infusion itself. The tincture is blood red; the colour is scarcely altered by sulphuric acid, on saturating it with salt of tartar it turns rather purplish, and yields a thick sediment, which on adding water is dissolved, and the tincture becomes violet. By digesting logwood in warm water, filtering the liquid and evaporating it to dryness, and digesting the extract in spirit of wine, specific gravity 0·837, filtering this tincture, and evaporating off part of the spirit, the colouring matter of this wood, or hematine, is deposited abundantly in small brilliant crystals of a reddish white colour, slightly astringent, bitter, and acrid.

Kino.—African red astringent gum, as ordered by the College, is at first insipid, then rough and rather sweet, and does not colour the spittle; the powder is reddish brown. It is soluble, but not entirely, in water; the solution is brick red and remains thick, but on adding a solution of salt of tartar, it becomes clear without depositing any sediment. Nitric acid added to the solution occasions a scanty reddish yellow precipitate to fall slowly down. Spirit of wine dissolves about 66 per cent. of it, and extracts all the colouring ingredient; the tincture is a deep brown.

The substance now sold for kino, and said to be the produce of the pterocarpus erinacea, forms a brown solution with water, which is rendered clear by salt of tartar, but affords a copious brown precipitate immediately on the addition of nitric acid: with solution of isinglass, a rose coloured precipitate is formed, and with green vitriol a deep green precipitate; so that the part of kino that is soluble in water differs slightly from the tannin of nut galls.

Pterocarpi Lignum.—Red sanders wood is of a fine red, but it breaks up before the planeing iron, and has of course a pitted surface. It does not communicate its colour to water: spirit of wine forms with it instantly a fine red tincture.

Quercûs Cortex.—Oak bark is acerb and styptic: the infusion is gold yellow, and has a faint smell; it grows black immediately on adding green vitriol. The tincture is similar to that of nut galls.

Rosæ Gallicæ Petala.—The dried petals, or bloom of the red rose, are styptic, bitterish, and tinge the spittle violet; the smell is improved by drying. Red roses colour water red; the infusion is also bitter, and grows of a brownish green on adding green vitriol. It had been supposed that their red colour was derived from oxide of iron, but this oxide has been found in a larger proportion in white roses. The real colouring matter is precipitated from the decoction by sugar of lead.

Salicis Cortex.—Sallow bark, or that of the salix capræa, ordered by the London College of Physicians, has not been examined chemically. The bark of the sweet willow, or bay-leaved willow, salix pentandra, originally recommended by Speckbuck in 1769, under the name of salix laurea, from the aromatic odour of its leaves, whose distilled water seems by the smell to contain prussic acid, yields a yellowish bitter solution growing black with green vitriol; the extract by water is also bitter. The Dublin College orders the bark of the common crack willow, salix fragilis, or of the white willow, salix alba. The bark of the latter is remarkably astringent, and contains much tannin, as also a bitter principle, extractive, and gluten.

Tussilago.—Colts-foot leaves are scentless, bitterish, and when chewed mucilaginous: the infusion is yellowish, and grows black immediately with green vitriol.

Tormentillæ Radix.—Sept-foil root is very styptic, scarcely aromatic: the infusion is red, grows immediately very black with green vitriol, and yields a precipitate with solution of isinglass.

Uvæ Ursi Folia.—Bear-berry leaves are scentless, slightly bitter, yield a greenish yellow light brown powder; the infusion is yellowish, instantly growing black with green vitriol: the watery extract is blackish brown, smelling like honey or extract of dandelion, bitter and astringent: 4 oz. gave 12 dr. of extract, and the residuum yielded 4 scr. of resinous extract with spirit of wine. They contain tannin, bitter extractive, gallic acid, and some rosin.

Ulmi Cortex.—Elm bark is scentless, rather bitter and slimy: the infusion is limpid, reddish, rather insipid, and turns of a blackish brown with green vitriol; the remaining bark feels slimy. The decoction of the bark of the trunk is red, slimy, and grows black immediately with green vitriol; that of the twigs is dark red or brown, draws into threads, and by evaporation yields a brittle semitransparent extract, soluble in water, but not in spirit of wine or in ether. As the infusion or decoction scarcely affects the solution of isinglass, elm bark probably contains but little tannin.

Weak Astringents.—The weaker astringents, ordered as drugs by the London College, are cocci, elaterii poma, humuli strobili, juniperi cacumina, lavandulæ flores, lauri baccæ, mentha viridis, rhæi radix, rubiæ radix, and sennæ folia.

Cocci.—Cochineal smells faint and heavy; it is bitter and austere: the powder is purplish red. The infusion of these insects is violet crimson, which colour is rendered brighter by acids or by alum; with green vitriol it yields a brownish violet precipitate, and becomes itself pale brown; sulphate of zinc or sugar of lead causes a violet precipitate, and the liquor is left colourless. Spirit of wine makes a deep crimson tincture, which by spontaneous evaporation produces fine red crystals. When these crystals are dissolved again in very pure spirit, and the solution mixed with an equal measure of ether, a beautiful purplish crust of the animal principle, cocheniline or carminium, is slowly deposited. This being mixed with peroxide of copper and heated, yielded no other gas but carbonic acid, and hence it contains no azote.

Elaterii Poma.—Spurting cucumber juice, as it flows from the nearly ripe fruit when cut, but without any pressure, is the part of the plant that yields the feculence improperly called by the College extractum elaterii, by merely letting it stand for some hours, pouring off the liquid, and drying the sediment by exposing it to the air, without employing heat. The feculence thus obtained, and which is distinguished on the Continent by the name of elaterium album, is pale greenish gray, dry, brittle, scentless, acrid, slightly bitter; when chewed it burns the tongue and fauces. Digested in water, nearly one half is dissolved, and tinges the liquid of a yellowish colour, communicating its own taste to it. Spirit of wine, sp. gr. 0·816 at 66° Fahr. dissolved only about one tenth of elaterium; the tincture was green, and left on evaporation, a green resinous extract, from whence water took up a very minute quantity of an extremely bitter substance, and left a residuum called elatine; to which vegetable principle the strong cathartic powers of elaterium are due. Another kind of extract obtained from the fruit by strong pressure and exposure to heat, which is of a dark green resinous appearance, and called on the Continent elaterium nigrum, is often sold for the College extract. Half a bushel of the fruit yielded only 2 drams of the proper extract; on another trial, 40 of the cucumbers yielded 6 gr., so that it is by far the dearest article in the present materia medica.

Humuli Strobili.—Hops are fragrant, rather narcotic, very bitter, spicy, astringent; the infusion is pale straw colour, turning olive by green vitriol, muddy by acids, and yielding a precipitate with spirit of wine, or sugar of lead. Distilled with water it yields an essential oil, and the decoction by evaporation, furnishes a bitter extract. A tincture of 5 oz. to 2 pints of proof spirit, is ordered to be kept. One part of hops are usually boiled for some time in the infusion of 40 parts of malt, previous to its being fermented for malt liquor; but the Swedes first boil the hops in water, and save this dark-coloured decoction to be added to the second infusion of the malt for inferior beer; then boil the hops again in fresh water, and add this second decoction to the first infusion of their malt for the best beer. The first decoction is esteemed too narcotic, and the second to hold the bitter principle in a state fit for preserving the beer, and rendering it tonic, and a preventive against calculous complaints.

Juniperi Cacumina.—Juniper tops are grateful, slightly bitter; the infusion is golden yellow, limpid, aromatic both in smell and taste, and turns brown with green vitriol.

Lavandulæ Flores.—Lavender flowers have a strong, fragrant smell; taste aromatic, bitterish and rather warm, heating the mouth when chewed. The infusion is reddish, fragrant, bitter, and grows black with green vitriol. The distilled water is fragrant; the essential oil is yellow, 15 lb. produced 5 oz. and an half, 80 lb. gave 1 lb. 9 oz.: the oil is taken over with spirit of wine in distillation, and forms a fine fragrant spirituous water; but the lavender water in the shops is usually made by dissolving the oil in strong spirit of wine. The foreign oil of lavender, or true oil of spike, is distilled from the tops of a different variety, if not species of lavender, by a quick fire. The oil of lavender, rubbed on the binding of books, prevents its becoming mouldy: a few drops of it may be added to flour paste with the same intent.

Lauri Baccæ.—Bay berries are bitter, aromatic, astringent; the infusion is purplish, red, bitter, balsamic, and turns more purple by green vitriol. By boiling in water for an hour in a close vessel, they yield oil of bays, which is butter-like, green, very bitter, and aromatic; it burns by means of a wick, and yields very little smoke. By expression they yield an oil at first liquid and afterwards butter-like, which is nearly insipid. By distillation with water, a limpid, yellow, aromatic oil is obtained.

Mentha viridis.—Spear mint is aromatic, slightly bitter; the infusion is reddish yellow, becoming greenish black with green vitriol; with water it yields an aromatic water, and an essential oil; the tincture is also aromatic.

Rhei Radix.—Turkey rhubarb is aromatic but disagreeable, bitter, slightly astringent, rather acrid, gritty when chewed, and colours the spittle yellow; the grain is rough, the powder bright yellow. Boiling water dissolves 40 per cent.; the infusion is limpid, yellowish red, growing greenish black with green vitriol, yields a scanty precipitate with lime water, solution of corrosive sublimate, or sugar of lead. Spirit of wine dissolves 27 per cent.: the tincture is gold yellow, not altered by adding water, but is turned blackish olive green by green vitriol. Ether dissolves 15 per cent.; the ethereal tincture is gold yellow, and on evaporation leaves a yellow rosin.—East Indian rhubarb is more disagreeable to the smell, nauseously bitter, grain compact and smooth, powder reddish yellow; water dissolves 50 per cent.; the infusion is pale, thick, and affords more precipitate on adding a solution of isinglass than that of Turkey rhubarb; it also yields a copious precipitate with lime water, solution of corrosive sublimate, or sugar of lead. Spirit of wine dissolves 40 per cent.; the tincture is brownish yellow, is rendered slightly turbid by adding water, and yields a copious green precipitate with green vitriol. Ether dissolves only 2 per cent.; the ethereal tincture is deep coloured.—By digesting the remains of the infusion in spirit of salt, and afterwards adding spirit of sal ammoniac, oxalate of lime is precipitated. The Turkey rhubarb yielded 43·3 per cent. and East Indian 30, of this oxalate.—The rhubarb cultivated in Europe appears to contain more gummy matter than the foreign, as the remains of its infusion formed a coherent gelatinous mass, of a saffron colour; it is, however, equally purgative, but less astringent and tonic.

Rubiæ Radix.—Madder roots are unpleasant to the smell, bitterish, slightly astringent and austere; the powder of madder is red, attracts the moisture of the air, and is injured by it. The infusion by cold water is red, by boiling water brownish red; both grow brown with green vitriol. By steeping the madder a certain time in water, and precipitating the infusion by potasse, a much finer red may be obtained. Hence it probably contains three colouring principles. Madder is remarkable for communicating its colour to the milk, bones, and dung of animals who are fed upon it. Bones thus tinged, are more brittle than ordinary, and the callus formed on the broken thigh bones of pigeons thus treated, was large, spongy, and uneven.

Sennæ Folia.—Alexandrian senna is faint and sickly to the smell, bitter, aromatic, rather nauseous. The infusion is deep red, rather bitter nauseous; the colour is not altered by green vitriol; by boiling, it becomes thick and mucilaginous, the extractive principle absorbing oxygen from the air. The extract, of which it yields about one third its weight, is black, glutinous, having a weak smell of wort. Spirit of wine extracts a deep green tincture, which is only rendered slightly milky on adding water. Ether also forms a green tincture, which communicates a gold yellow colour to water, and by the evaporation of the ether, a pellicle of olive-green rosin is left on the surface. The stalks are equally efficacious with the leaves, and the griping quality is not occasioned by them, but by the too long exposure of the infusion to the air, which oxygenizes the extractive matter, and renders it insoluble.

Filicis Radix.—The only decidedly sweet astringent of the College list of drugs, is the male-fern root. This has a weak, rather nauseous smell; it tastes at first sweet, then slightly bitter, astringent, but not nauseous; when chewed it is rather spicy and mucilaginous. The infusion is clear, yellowish, smelling like mushrooms, tasting like the root itself, growing black with green vitriol.

These austere and acerb substances are all astringent, and are far more antiseptic than common salt, because they contract the fibres and augment their cohesion, thus preventing the too quick motion of the intestines, and the too quick digestion of the food. They contract the pores, and coagulate the fluids; hence they are useful in all hæmorrhages, in night sweats, and all fluxes attended with heat; and they are cooling in inflammations and in erysipelatous eruptions; but their use ought to be preceded by purging or blood-letting. In bodies of a lax habit they strengthen the fibres, and are the best healers in wounds and ulcers of all kinds. They are also useful in many chronic disorders, as cachexy, scurvy, and the calculous diseases that arise from a weak or ulcerated state of the kidneys.

Acid and saline Combustibles.—The fifth class of compound combustibles includes all the combustible acid and saline bodies. Of these so few are reckoned as drugs, that the class is not subdivided; the College list contains only acetosæ folia, acetosella, aurantii baccæ, cerevisiæ fermentum, limones, mori baccæ, potassæ supertartras, and tamarindi pulpa.

Acetosæ Folia.—Sorrel leaves are strongly acid but grateful; by drying their acidity is lessened, and they grow earthy. The expressed juice is greenish, with a faint smell, and rather acid taste; it is not changed by green vitriol, and effervesces slightly with salt of tartar: being left to settle, the clear liquor poured off yields, by evaporation, an essential salt, the binoxalate of potasse.

Acetosa.—Wood sorrel is pleasantly acid; when chewed it sets the teeth on edge; by drying, it loses much of its acidity. The expressed juice clarified by settling and boiling with a little fine clay, affords, by repeated evaporation and crystallization, 3 or 4 oz. of essential salt from 20 lb. of the green herb; the residuary liquor is still acid although it will not yield any more crystals. This essential salt is the binoxalate of potasse, used to take out iron moulds from linen, under the name of essential salt of lemons: it is also a delicate test of the presence of lime in mineral waters, causing an immediate precipitation of oxalate of lime from them. A conserve was formerly prepared from these leaves, having the name of conserva lujulæ; used to dissolve in water, and form a pleasant cooling drink in fevers.

Aurantii Baccæ.—By this name the College mean the juice of Seville oranges, which is acid, bitter, and aromatic: it contains much citric acid. There was formerly an acid syrup prepared from it, but this being no longer ordered, there seems no occasion to retain this drug in the list.—The juice of the sweet orange is more generally used as a pleasant cooling drink.

Cerevisiæ Fermentum.—Yeast, or barm as it is called in some dialects of the English language, floats on the surface of fermenting worts in the preparation of malt liquors. Its composition is not known. When it is filtered, a substance resembling the gluten of wheat is left on the strainer, and the filtered liquor has lost the power of promoting fermentation: this substance also separates from yeast by standing some time, and forms a white curd on its surface. A small quantity of yeast is sufficient to commence the fermentation of a large quantity of wort; the brewers usually put a gallon to every 96 gallons of wort, but the distillers, to accelerate the fermentation of their wash, add a much larger proportion of yeast. This substance is also used to determine the rising of bread, in all which cases, it acts by decomposing the sugar contained in the mass, and converting it into some other substance. From the great use made of it, yeast is frequently scarce, especially in summer; but it may be obtained, by first boiling half a gallon of malt for a few minutes in 3 pints of water, strain 2 pints and let it stand to ferment, which, if hops are added, will take place in 24 hours, but if not hopped will require about 60 hours; then mix in 4 pints of a similar decoction of malt, and thus keep adding a larger quantity of wort, until you have yeast enough. For baking, yeast is multiplied by mixing 2 lb. with paste, made of 10 lb. of flour and 16 lb. of boiling water, and keeping this mixture warm for 6 or 8 hours. Yeast is used medicinally as an antiseptic, and externally in cataplasms, to supply carbonic acid gas.

Limones.—Lemons are kept in the shops for their juice, which is a very grateful acid; but the extractive matter contained in it, does not allow it to be kept for any time unless that be separated. To obtain the pure citric acid; the lemon juice is saturated with powdered chalk, and thus converted into a citrate of lime; which being but slightly soluble in water, is well washed with water, to remove all the extractive mucilage and sugar present in the juice. A quantity of citrate of lime is imported, made either from lemon juice, or, which is most common, from lime juice. The citrate of lime being diffused in water is mixed with dilute sulphuric acid, which unites with the lime and sets free the citric acid; the liquor being then strained, to separate the sulphate of lime, some part is evaporated by a very gentle heat, and the remainder is left to evaporate spontaneously in a draught of air. The crystals thus obtained, are purified by re-dissolving them in water, and crystallizing them afresh by spontaneous evaporation, as the citric acid is changed by the slightest heat. Citric acid is soluble in four fifths its weight of water, but the solution alters by keeping; a dram of the crystals dissolved in 2 oz. meas. of water, is equal in strength to lemon juice, and is used for making saline draughts, by saturating it with salt of tartar; but it is not antiscorbutic like the original lemon juice. The crystals of citric acid are composed of 79 per cent. of citric acid and 21 of water. The citric acid itself is supposed to be $4\,C + 3\,H + 4\,O$.

Mori Baccæ.—Mulberries have but little smell, and are only slightly acid; they colour the saliva dark violet. They yield rather more than half their weight of reddish juice, tinging the skin. The acid they contain is the tartaric.

Potassæ Supertartras.—Cream of tartar is now admitted as a drug; the crude tartar, or argol, being rejected, although some prefer it as less apt to gripe than the purified kind. Crude tartar is deposited on the casks in which wine is kept, and particularly from wine which has been made from grapes not thoroughly ripened, and is purified by solution in water, and crystallization by continued evaporation.

It is a combination of 2 charges of tartaric acid with 1 of potasse, mixed with about 5 per cent. of tartrate of lime. Cream of tartar is very slightly soluble in water, a pint scarcely dissolving a quarter of an oz.; the solution is converted, by keeping, into a solution of carbonate of potasse, a mucous matter being deposited On heating, it yields an excessive quantity of carbonic acid gas, and carburetted hydrogen gas, oil, and pyrotartaric acid. The saline residuum is a carbonate of potasse, and this was formerly the usual method of obtaining that salt; at present, the subcarbonas potassæ e tartaro is seldom used, except in making up old prescriptions, and even in this case, the purified pearl ash is actually used; it is proper, however, to keep a small bottle of purified pearl ash, labelled sal tartari, and another labelled sal absinthii, because these are frequently asked for, and fetch a higher price than under the other name.

Cream of tartar being added to a hot solution of salt of tartar until an effervescence is no longer produced, and the liquor evaporated to a pellicle, crystals are formed, by cooling, of tartrate of potasse, which being soluble in its own weight of water, is called also soluble tartar. In this operation, the tartaric acid expels the carbonic acid, and combines with another charge of potasse; so that this salt consists of 42 per cent. of potasse, and 58 of tartaric acid. If cream of tartar is saturated in like manner with purified barilha, a compound salt, commonly called Rochelle salt, is produced, the soda tartarizata of the College, and which is conceived to be a combination of one particle of tartrate of potasse with one particle of tartrate of soda. This salt is nearly as soluble as the neutral tartrate of potasse, and like that salt is used as a cathartic and laxative.

Cream of tartar acts on metals without parting with its alkali. In the Pharmacopœia there is the ferrum tartarizatum, prepared by grinding equal weights of iron filings, cream of tartar, and water, exposing them to the air for a week, then drying it, and repeating the process with fresh water: by which a combination of tartaric acid, potasse, and iron is obtained, or rather one in which the cream of tartar acts as an acid.

The union of cream of tartar with oxide of antimony has been attempted in a variety of methods, on account of the salt resulting from it being an excellent emetic and alterative, in very general use. The College process is rather complicated: 2 oz. by weight of oil of vitriol, is diluted with 12 oz. by measure of water; to this is added, by degrees, 2 oz. of the common antimony, or sulphuret of that metal, previously ground with 1 oz. of salt petre; the mixture is boiled for half an hour, by which a subsulphate of antimony is probably formed, which being well washed, and, while moist, thrown into a solution of 3 oz. of cream of tartar, in 12 oz. of water, boiled for a short time, and set by to crystallize, affords crystals of emetic tartar, in which, as in the former preparation, the cream of tartar probably acts as a simple acid, and hence the College name of antimonium tartarizatum. The theory of the whole is obscure: in the preliminary process, the nitric acid of the salt petre is decomposed; nitrous gas being disengaged, and the oxygen probably converts the sulphur of the common antimony into sulphuric acid, and the antimony metal into a protoxide, which unite together into a subsulphate; which is partly decomposed in its turn by the cream of tartar uniting with the extra proportion of oxide, and reducing it to the state of neutral sulphate. Manufacturers generally use a more direct process, and boil equal weights of cream of tartar and glass of antimony, in 10 or 12 times their weight of water, then filter, evaporate till a pellicle of salt is formed, and then leave it to crystallize. Emetic tartar seems to be composed of a particle of tartrate of potasse united with one of subtartrate of antimony, or 44 per cent. of tartaric acid, 40 of protoxide of antimony, and 16 of potasse.

Emetic Tartar.—Emetic tartar exposed to the air loses its transparency, it is soluble in about 14 times its weight of water. The solution will not keep unless a large proportion of spirit of wine is added. It yields, with sulphuret of ammonia, a copious golden yellow precipitate; with lime water, a white extremely thick precipitate, dissolving with great ease in nitric acid; with a solution of sugar of lead, a precipitate also soluble in nitric acid. It is likewise precipitated by many acids, the alkalies, and their carbonates, and by the infusions of the bitter and astringent vegetables, particularly by that of yellow bark, which is one of the best remedies, if an overdose has been given. It is not affected by neutral sulphates, and in combination with Glauber's salt forms the emeto-purgative much used in France.

The College now orders the oxydum antimonii to be prepared by mixing a solution of 2 oz. of tartar emetic with a solution of 2 dr. of their subcarbonate of ammonia, or volatile sal ammoniac; here the ammonia separating from the carbonic acid unites with the tartaric acid and potasse, and obliges them to let go the oxide, which falls down, and is to be well washed from the tartrate of potasse-and-ammonia, or perhaps ammoniated tartar, that is formed.

Tartaric Acid.—The tartaric acid may be obtained from cream of tartar, by adding to its solution powdered chalk, until no effervescence is occasioned; the lime of the chalk combines with the second charge of acid, and forms a tartrate of lime, which is to be well washed to separate the soluble tartar, or neutral tartrate of potasse, that is disengaged. The tartrate of lime is then decomposed by the addition of diluted sulphuric acid, which forms sulphate of lime, separable by straining, and the freed tartaric acid is obtained from the filtered liquor by evaporation and crystallization: the quantity of the acid is generally one third that of original cream of tartar. If too much sulphuric acid is added, the precipitate occasioned by dropping in a solution of sugar of lead, will be insoluble in distilled vinegar. The crystals of tartaric acid contain about 88·5 per cent. of acid, with 11·5 of water; the acid itself being $4\,C + 3\,H + 5\,O$.

The tartaric acid is not ordered in the Pharmacopœia, but is used as a cheap substitute for citric acid, for making saline draughts.

Tamarindi Pulpa.—Sour tamarinds are probably those meant to be ordered by the College, as they are used for a refrigerant; the pulp is mixed with the seeds and strings, and contains not only citric acid, but also the tartaric and malic acids, and the supertartrate of potasse.—The sweet tamarinds are mixed with syrup and sugar, and having been boiled in a copper, usually contain so much copper as to tinge a knife thrust into them for a few hours, with a copper colour.

Of acids, it may be remarked in general, that the native acids of plants are for the most part not distillable without alteration; their taste is strong yet without any apparent heat; they quench thirst, break wind, and render the phlegm thinner. Acids are grateful to the stomach, cooling in bilious and putrid fevers, and correct the acrimony of the bile. They are antiseptic, and correct any putrid tendency in the primæ viæ; they are also useful against worms from the same cause. Acids have, moreover, an astringent, repellent, and discutient power; but it must be observed, that not only the mineral acids, but also the vegetable acids, have a considerable power of corrosion: lemon juice taken in too large doses has been known to corrode the stomach, and occasion aphthæ there, and their tendency to produce phthisis when used too liberally, is well known. They are therefore hurtful to diarrhœa, dysentery, and cholera accompanied with a febrile heat.

Aromatic Bodies.—The sixth class of compound combustibles is composed of the aromatic, balsamic, and strongly scented substances. They are subdivided into five divisions, namely: 1. The pure aromatics; 2. the bitter aromatics; 3. the balsamic substances; 4. the fragrant substances; and 5thly, the fetid substances of this class.

The pure aromatics, or warm spicy substances, chosen by the London College, are, anethi semina, anisi semina, aurantii cortex, canellæ cortex, cardamomi semina, carui semina, caryophylli, caryophylli oleum, cinnamomi cortex, cinnamomi oleum, coriandri semina, cumini semina, dauci semina, mentha piperita, myristicæ nuclei, myristicæ oleum expressum, omitted in the materia medica, but used in the preparation of the emplastrum picis compositum, origanum, sassafras radix, and serpentariæ radix.

Anethi Semina.—Dill seeds are spicy, fragrant; 4 lb. yielded 2 oz. of yellowish essential oil; the water is alone ordered.

Anisi Semina.—Anise seeds are spicy, sweetish, and agreeable; 8 lb. yields, by distillation with water, 2 oz. 6 dr. of essential oil, but with anise seed water, 3 oz. The essential oil is lemon yellow, having the smell and taste of the seeds, but sharper; when fresh, it congeals at 53° Fahr.; but when old and rank it loses this property; it is a poison to pigeons, if a few drops be put on the bill and rubbed on the head. A greenish oil is also obtainable by expression. The distilled water is spicy and agreeable; a tincture and extract, both of which are warm, may be made by spirit of wine.

Aurantii Cortex.—The yellow part of fresh orange peel is fragrant, but not so agreeable as citron peel; bitter and spicy, warmer than lemon peel, and the flesh is bitter. The fresh peel affords an essential oil, either by expression or distillation: this oil is yellow and very fragrant, particularly that by expression. The distilled water is warm, rather bitter, and one of the best vehicles for medicines. The

College tincture is made of 1 oz. and half of fresh peel to the pint of proof spirit. The distilled spirit is aromatic.

Canellæ Cortex.—White cinnamon is spicy, resembling cloves and cinnamon mixed; the taste is extremely warm and pungent, but slightly bitter. The infusion dissolves a quarter of its weight, is yellowish, aromatic, not changing colour with green vitriol, nut galls, white vitriol, corrosive sublimate, or emetic tartar; but it yields precipitates with nitrate of silver and sugar of lead. The decoction resembles small beer, is bitter, less spicy than the infusion. The distilled water is fragrant, and accompanied with a dark yellow essential oil. The tincture is bright yellow, and turns milky with water.

Cardamomi Semina.—Cardamom seeds, when extracted from the capsules in which they are kept, have a very pleasant spicy smell and taste. The infusion is spicy, rather thick, not altered in colour by green vitriol, but yielding a precipitate with corrosive sublimate, sugar of lead, spirit of wine, and several acids. Distilled with water they yield a yellow essential oil, swimming on the distilled water. The tincture is warm, as is also the spiritous extract. The ethereal tincture is yellowish green, and when evaporated on water leaves much essential oil floating on it.

Caryophylli.—Cloves are fragrant, very warm, rather acrid; the infusion is red, very fragrant, spicy, hot, turns black with green vitriol. The distilled water is fragrant; the essential oil, of which it yields one lb. in seven, is limpid, red, sweetish to the taste, but extremely hot, heavier than water. The tincture is hot, reddish, and by evaporation yields an extract, smelling less strongly of the cloves, but extremely hot. The ethereal tincture is also hot and strong smelling; on mixture with water, a yellowish green oil separates by degrees, and afterwards, by evaporation a very pungent, hot rosin. A little powdered cloves is frequently added to flour paste, or ink, to prevent them from growing mouldy.

Caryophylli Oleum.—Foreign oil of cloves, being drawn from the fresh unopened flowers, is of a deeper red than the European oil, extremely pungent and fiery. This oil takes fire on the addition of nitric acid to it.

Cinnamomi Cortex.—Cinnamon has a peculiarly sweet, spicy taste; it yields a red infusion, with the odour of the bark, a sweetish taste, neither bitter nor acrid, but rather astringent, and turns brown with green vitriol. Being kept in a gentle heat the infusion becomes covered with a reddish brown pellicle. The decoction is red, smelling like cinnamon, taste rather astringent, and less agreeable than the bark, it turns black with green vitriol. The watery extract is slightly astringent. The tincture is deep red, and yields an aromatic extract by distillation. The distilled spirit has much of the smell and flavour of the bark. The distilled water is fragrant, aromatic, and very slightly astringent. The essential oil requires a strong heat to carry it over, and separates very slowly from the distilled water; it sinks in water, is acrid, very fragrant, extremely hot, with the smell and taste of the bark. This oil after keeping for 20 years deposited a few crystals of a resinous nature. On account of its dearness the essential oil of cassia buds is frequently sold for it; but the oil of cinnamon may be distinguished by the bead of bubbles, formed by shaking it, remaining for some time, while in the other oil they vanish almost immediately. —Cinnamon is one of the drugs used to aromatize the liquor ammoniæ, and form the spiritus ammoniæ aromaticus of the present Pharmacopœia, which is prepared by adding cinnamon, cloves, and lemon peel, to spirit of wine, water, sal ammoniac, and salt of tartar, and distilling over a part thereof: in this operation, the potasse of the salt of tartar unites with the muriatic acid of the sal ammoniac, and sets the ammonia free, which uniting with the spirit of wine, they carry over some of the essential oils of the vegetables, and thus form an aromatized alkaline spirit; which is employed in pharmacy, to extract the medical virtues of valerian and Peruvian bark, and thus produce what are called ammoniated tinctures.

Cinnamomi Oleum.—Foreign oil of cinnamon is more aromatic than that prepared in Europe, and is the sort usually employed: 80 lb. of cinnamon, distilled with sea water, as usual in Ceylon, yielded about 5 oz. of a heavy oil, and 2 oz. of an oil swimming on the distilled water: the two oils are probably mixed for sale, and it is usually computed than 11 lb. of coarse unsaleable cinnamon yields on an average an oz. of oil.

Coriandri Semina.—Coriander seed is spicy, but not pleasant; the infusion has only a weak smell and taste; it is not changed by green vitriol; 164 lb. of dry seed yielded 5 oz. and an half of a yellow liquid oil.

Cumini Semina.—Cumin seed has a strong, heavy smell, and a spicy taste; the distilled water is aromatic, smelling of the seed; 25 lb. of fresh seeds yielded 12 oz. of yellow essential oil.

Dauci Semina.—Carrot seed (ordered by the College to be collected from wild plants) has a spicy, warm, and bitterish flavour; the decoction is extremely bitter.

Mentha Piperita.—Peppermint has a fragrant, rather camphire-like smell, the taste is aromatic, and very hot; on chewing, it first heats the mouth, and then a coldness succeeds; both smell and taste are increased by drying. The infusion is reddish, slightly fragrant, yet of a heavy smell; tastes at first weak, afterwards hot; grows brown with green vitriol. The distilled water milky, very hot, fragrant, and spiritous; the essential oil brownish red, lighter than water, smelling strongly of the plant, taste extremely hot and fiery, first emitting a suffocating vapour down the throat, heating, then seeming cold, afterwards burning the lips and tongue for some time, the heat not removable by washing the mouth: this oil contains much camphire, which may be obtained even from the herb itself when thoroughly dried before it is distilled. A single drop of the oil gives a strong fiery taste to half a pint of water; it is soluble in spirit of wine, and this essence, as it is called, may be used to make a substitute for the distilled water, from 15 to 45 drops of the oil being dissolved in about ten times as much spirit, and then added to two pints of water. Spirit of wine distilled from this herb carries over part of the oil, and becomes impregnated therewith.

Myristicæ Nuclei.—Nutmegs have a pleasant fragrant smell; taste fattish, spicy, warm; on chewing, they are friable, easily broke, and almost dissolve in the mouth, which they warm very much. The infusion is limpid, yellowish, having drops of oil swimming on it, aromatic, turning slightly brown with green vitriol. The saturated decoction is thick, emulsion-like, with an oily scum, tastes fat and spicy. On expression nutmegs yield 6 oz. in the lb. of a half liquid butter-like oil, when fresh yellowish, but it grows harder by age, and becomes of a mottled white. This oil is fat, sharp, bitterish, easily melted, and on bringing a candle near it the melted oil takes fire, burning with a vivid, broken flame, with scarcely any smoke or soot. Nutmegs yield also an essential oil, which by distillation with water is yellowish, liquid, with the smell and taste of the nuts, sp. gr. 0·948; this oil is carried over by spirit of wine, to which it communicates its smell and taste. The ethereal tincture is gold yellow, limpid; evaporated on water, the essential oil is left, and a white opaque fat-like substance is deposited at the bottom of the water; spirit of wine extracts more essential oil from this matter and leaves a kind of wax.

Myristicæ Oleum expressum.—The expressed oil of nutmegs, usually called oil of mace, although ordered to be used in the composition of the emplastrum picis compositum, is omitted by the College. In the former editions the foreign oil was quoted, and therefore the omission is in the enumeration of the materia medica: its qualities are mentioned in the preceding article.

Origanum.—Marjoram is sweet scented, not unpleasant; the taste is spicy weaker than mint; the infusion is red, spicy, but rather bitter; grows black with green vitriol. It yields a very acrid essential oil, spec. gr. 0·94.

Sassafras Radix.—Sassafras chips are sweet scented, with a spicy taste; the infusion is deep red, with the smell and taste of the root, growing slightly brown with green vitriol. The distilled water is aromatic, the essential oil, of which 10 oz. were obtained from 60 lb. of the chips, sinks in water, is very fragrant, when fresh a clear yellow, grows red by age, extremely hot, and pungent to the lips. The tincture takes up all the smell and taste, and leaves, on evaporation, a very aromatic spiritous extract.

Serpentariæ Radix.—Virginia snake root is fragrant and balsamic, but strong; its taste is rather warm and lasting; when powdering it affects the nostrils considerably. The infusion is clear, sweet scented, tastes hot, not altered by green vitriol, white vitriol, nitrate of silver, corrosive sublimate, emetic tartar, solution of isinglass or of tannin, the usual acids nor alkalies; but it yields with sugar of lead a precipitate that is not soluble in vinegar. The watery extract is merely bitter, the spicy aroma being dissipated by the boiling. The distilled water is fragrant, as also the essential oil. The tincture is bright green, and rendered thick by water.

Pure aromatics are used as stimulants, and partly as correctives to other medicines. They are useful whenever the circulation is to be promoted, but hurtful in full habits, or when the body is costive; in fevers and fluxes of all kinds.

Bitter Aromatics.—The only decidedly bitter aromatic of the College list is guaiaci lignum.

Guaiaci Lignum.—Lignum vitæ raspings have, when warm, a weak, rosin-like smell; when chewed, they are bitter and rather biting. The infusion is yellowish, the smell weak, resinous, the taste resinous and bitterish; it is not altered by green vitriol. The watery extract, of which 2 lb. yields an ounce, is gummy resinous. Its medical use is merely stimulant and detersive.

Balsamic Substances.—The balsamic substances of the Pharmacopœia are numerous, namely, abietis resina, balsamum Peruvianum, balsamum Tolutanum, benzoinum, copaiba, elemi, juniperi baccæ, mastiches, olibanum, petroleum, pix arida, pix liquida, resina flava, resina nigra, rosmarini cacumina, succinum, styracis balsamum, terebinthina Canadensis, terebinthina Chia, terebinthina vulgaris, and terebinthinæ oleum.

Abietis Resina.—Perrosin, or common frankincense, is whitish yellow, soft, rather fat, slightly transparent, sweet scented, tasting bitterish, balsamic, and not unpleasant, greasing the fingers; it melts easily, and on bringing a flame near, it takes fire; burns exactly like tar, and leaves scarcely any charcoal. It yields a thin oil by distillation, much inferior to oil of turpentine, and not possessing the same qualities; by boiling in water until it is melted, and straining through canvass bags, it is changed into Burgundy pitch; a longer boiling, to the consumption of the water, and adding vinegar towards the end of the boiling, produces one kind of brown rosin. It is soluble in spirit of wine, forming a transparent tincture.

Balsamum Peruvianum.—Black balsam of Peru has a sweet smell, tastes warm, bitterish, slightly acrid; when cold it does not catch fire from a flame, but when warm it takes fire, and burns with a vivid, yellowish, smoking flame. It sinks immediately in water, and does not dissolve therein; but if shaken up with warm water it communicates its own smell thereto, and the liquid is found to be impregnated with benzoic acid. Distilled with water it yields about one 16th of essential oil, and a little benzoic acid is sublimed; this oil is reddish, sweet scented, pungent, and soluble in spirit of wine. Distilled without water it yields first a yellowish oil swimming on water, and then a heavier oil. Evaporated by itself, it leaves a black rosin, soluble in spirit of wine, but not in expressed oils, which absorb only its essential oil, without any alteration of their colour, and convert it into a tenacious mass like newly-prepared rosin of jalap, in which state it may be formed into pills; neither is it soluble in distilled oils, but they acquire a pale yellow colour, and the balsam grows thick like an ointment. Sulphuric, and especially nitric acid, convert it into tannin.

Balsamum Tolutanum.—Balsam of Tolu in gourds, which is probably that which the College intends should be used, is a brownish yellow turpentine, of an exceedingly fine sweet scent, it runs and may be drawn into threads in summer, but is solid in winter; when chewed it is not dissolved, but it grows soft and sticks to the teeth; the taste is warm and rather sweet. It is easily melted, and in that state takes fire from a flame, and burns vividly, yielding a copious, pleasant, balsamic, smoking fume. Held to the candle it takes fire, but soon melts, falls in drops, and the flame goes out. Rubbed with gum Arabic it may be suspended in water. Distilled with water it yields a small portion of essential oil, and some benzoic acid. It is soluble in spirit of wine; the tincture is rendered milky on adding water, but no precipitation takes place; with sulphuric acid it yields benzoic acid and tannin; with nitric acid the same; and there is also produced a smell of bitter almonds, so that the formation of prussic acid also is suspected. Dissolved in potasse water it acquires the scent of clove pinks, and this scent is very permanent.—Another species, called balsam of Tolu in jars, is in more common use, which is a solid resin, not altered by our summer heat; it agrees with the preceding in chemical characters, though very different in appearance.

Benzoin.—Gum benjamin, or perhaps more properly benjavin, the Sanskreet, or classical Indian name, being benjui, has a fragrant and pleasant smell; when chewed, it breaks down in the mouth, tasting resinous, and rather sweet; it does not adhere to the fingers; it soon melts, froths, and gives out a balsamic, pleasant fume, which catches fire from a candle, and burns with a vivid, smoking flame, leaving a brittle, shining, charcoal, that rather dirties the hands. Distilled by itself it yields about 9 per cent of crystallized benzoic acid; which, when procured in this manner, is called flowers of benjamin; 5·5 of acidulous phlegm, 60 of a butter-like burnt oil, 22 of charcoal, and 3·5 of carburetted hydrogen gas, mixed with carbonic acid gas. Water extracts part of its benzoic acid if distilled together; no essential oil comes over. Spirit of wine dissolves it; the tincture is rendered white by water; on evaporation, it leaves a blackish brown rosin, of a fine aromatic smell. Ether also dissolves it readily.—The benzoic acid is also separated by grinding 16 oz. of gum benjamin with 4 of lime, then boiling the mixture first in a gallon of water, and then in half a gallon; mixing the strained liquors, evaporating to an half, and dropping in about 4 oz. meas. of spirit of salt, until no more precipitate falls down: the liquor being poured off, the precipitated benzoic acid is dried, and afterwards sublimed, by a gentle heat, into flowers. In this process, the lime uniting with the benzoic acid, forms a benzoate of lime; this is decomposed by the muriatic acid uniting with the lime and setting the benzoic acid free; which, requiring 200 times its weight of water to dissolve it, falls down as a precipitate. Benzoic acid has a peculiar aromatic smell, and a sweet, hot, bitter taste; its composition is supposed to be $15\,C + 6\,H + 3\,O$.

Copaiba.—Balsam of capivi has a fragrant, not unpleasant smell; the taste is fat, bitterish, rather disagreeable, resinous; it renders paper transparent. When cold, it does not take fire from a flame; but when heated, it boils, smokes, catches fire from a flame, and burns vividly, with much smoke; the smell is not much altered, and it is almost entirely consumed; leaving only a black shining coating on the vessel. When fresh, it either sinks to the bottom of water, or a drop retains its spherical figure, and floats just under the surface; but here it always spreads on the surface, the sp. gr. being 0·95. Shaken with water it breaks into drops, some of which adhere to the vessel, but flow down slowly; by long trituration, it forms a milky liquid, but the balsam and water separate slowly by standing; this emulsion is rendered more permanent by adding gum Arabic, or the yelk of an egg. Distilled with water it yields a distilled water of its own smell; and a very limpid, fine, yellowish, essential oil, which by rectification became as clear as water, smelling like capivi, but more pleasant, and bitterer; 36 oz. of the balsam yielded 20 oz. of this oil, and 12 of a greenish brown rosin was left in the still. Distilled by itself, it yields first a yellow fragrant oil, then a blue empyreumatic, yet not unpleasant oil; a similar blue, and not unpleasant smelling oil is obtained by mixing the balsam with wood ashes, and distilling it by the retort. Capivi is soluble in spirit of wine, and also in ether and expressed oils. Sulphuric acid turns it into a bituminous mass; nitric acid dissolves it, and if in sufficient quantity would probably change it into tannin: the fixed alkalies form a soap with it.

Elemi.—Gum elemi has a strong smell, its taste is bitterish, when chewed it softens, but does not adhere to the teeth; worked in the hands it softens and sticks to them. It melts and boils, giving out the smell of frankincense: in the flame of a candle it takes fire, drops, and burns with a bright smoky flame, leaving some coal. Sp. gr. 1·0182. Distilled with water it yields one sixteenth of essential oil, nearly limpid, rather hot to the taste, and stronger scented than the elemi; the remaining rosin is scentless. Spirit of wine dissolves the greater part; the solution is lemon yellow, and a white matter is left which is soluble in water.

Juniperi Baccæ—Juniper berries are aromatic, with a peculiar scent; when chewed they are sweetish, bitterish, and pungent. The infusion of the slightly-bruised berries is limpid, yellowish, sweet, aromatic, of the powdered berries deeper and resinous. The essential oil, of which they yield about a fortieth part, is yellow, hot, lighter than water, and a rather turpentiney smell; in time it deposits a resinous sediment of a brown colour.

Masticnes.—Gum mastich has a weak balsamic smell, tastes warm and pleasant, when chewed it first breaks, and then forms a stiffish, white mass, like white wax. In the flame of a candle it melts and drops, but does not take fire. Melted in a ladle it diffuses an agreeable scent, but does not take fire from a flame, unless it be very hot, when it suddenly catches fire in every part, and burns with a bright, tall, smoky flame, with much smoke, and leaves a blackish coal, that slightly dirties the fingers. It does not dissolve in water, but communicates its smell thereto. Distilled with water, it yields an essential oil. Spirit of wine dissolves the greater part of mastich, leaving a tough elastic substance, which when dried becomes brittle, and thus differs from Indian rubber. A similar substance is obtained by passing oxymuriatic acid gas through the tincture of mastich.

Olibanum.—The College has ordered the gum of the juniperus lycia to be used under this name, but no such gum is procurable; and the natives of the countries where that plant grows, assert it does not yield any. The frankincense sold in England is the gum of the salai tree of India, which has a balsamic resinous scent, a bitterish taste, and when chewed it softens, sticks to the teeth, becomes white, and at last dissolves. At the flame of a candle it takes fire, does not melt nor soften, but burns with a bright, smoky flame, and is slowly consumed, leaving a shining coal. When heated in a vessel it sweats, and throws out a balsamic scent, whence it is used by the idolatrous sects both of the heathen and Christian churches to cense their images, and was formerly by the Jewish to perfume the place of worship. Afterwards the resinous part softens, boils on the surface, smokes, but the gum itself does not melt, nor flame: it only burns slowly, and produces much gray ash. Rubbed with water it forms an emulsion, from whence the resinous part subsides slowly, and leaves only three eighths suspended. Spirit of wine forms a clear yellow solution, but takes up only three quarters of it. Ether dissolves rather more than half, leaving a white opaque residuum, soluble in water: the ethereal tincture evaporated on water leaves a transparent rosin. Distilled alone, it yields a volatile oil, resembling oil of lemons in smell and colour. It was resolved into 8 per cent. of oil, 56 of rosin, 30 of gum, and 5·2 of a principle resembling gum, but insoluble in water as well as spirit of wine.

Petroleum.—Barbadoes tar was the species of bitumen enumerated in the old Pharmacopœias, and therefore it is probable that the College now intends the same article; but it is doubtful whether any is to be had in England: that sold under this name is the distilled oil of coals, or coal tar. The substitution is probably of little consequence, as the chemical properties are most likely the same, although the bitumens have been so slightly examined by chemists, that their chemical history is very obscure. Petroleum, however, is scarcely, if ever, prescribed by a regular practitioner, and is only kept in the shops for ferriers and private students. Fresh distilled mineral oil is soluble in four times its weight of spirit of wine, but by exposure to the air it becomes insoluble, and thus acquires properties similar to those of the solid bitumens, as asphaltum or amber.

Pix arida.—This is the new appellation ordered by the College to be given to what is usually called Burgundy pitch, instead of the black pitch formerly denoted by this

Latin name. Burgundy pitch is prepared by melting per-rosin or common frankincense in water, of which it no doubt absorbs a portion; it is soft, plastic, and when handled sticks to the fingers; at the flame of a candle it melts with some noise and partly drops; melted in a vessel it soon catches fire, burns with a large smoky flame, leaving a black coal, slightly dirtying the hands. Its toughness renders it useful for plaisters which are intended to remain on for some time, as the emplastrum cumini.

Pix liquida.—Tar is prepared from the Scotch fir by a distillation per descensum in a temporary reversed retort made of earth shovelled up, or dug out of the ground, or a kiln built of masonry of the same shape; the fire being so managed by openings constructed for that purpose, that the heat of the wood actually burning at the upper part, answering to the bottom of the retort, causes the distillation of the layer of wood under it, and when it is itself converted into charcoal, the openings being closed, and the next row beneath them opened, the further burning of that layer is stopped, and thus the combustion is gradually carried downwards, and the empyreumatic oil or tar produced runs off through a tube at bottom of the heap, answering to the neck of the retort.

Tar has a balsamic but smoky smell, and a fattish taste: as first it swims on water, but if shaken together it divides into drops which sink to the bottom. By heat it becomes more liquid and boils, in which state although hotter than boiling water, the hand may be dipped in it without scalding, or even any unpleasant feeling, owing to the extreme slowness with which it communicates heat. When heated, it catches fire very easily, and burns with a most vivid, smoking high flame, while several very brilliant ignited bubbles appear to arise from the tar, and pass through the flame, affording a very striking spectacle: there remains a black coal, sticking to the vessel, rough but rather shining, scarcely dirtying the hands. By boiling until one third is evaporated, or till it is solid when cold, and does not adhere to the teeth on being chewed, it produces black pitch; the vapour that rises is highly esteemed as a pulmonic remedy in phthisis. Tar stirred in water gives it a yellow colour, its own smell, and an acid slightly acrid taste; this tar water effervesces with a solution of pearl ashes, and causes a precipitation with the liquor plumbi acetatis; the acid of the tar water ejecting the acetous acid from the oxide of lead.

Resina flava.—Yellow rosin is made by melting turpentine and pine rosin together, adding water until the mass appears like yellow wax; or by distilling turpentine for its yield of oil, and pouring the rosin that is left in the still into warm water, of which it absorbs about one eighth of its own weight. Powder of yellow rosin is added to flour paste to prevent it from growing mouldy, but being less aromatic than cloves or the strong scented oils, is less efficacious, although cheaper.

Resina nigra.—Common rosin or colophony is obtained by distilling turpentine for the oil, being the residuum left in that process. It differs but little from yellow rosin. It does not conduct electricity, but by friction becomes negatively electrical, sp. gr. 1·080. Spirit of wine dissolves one third of its weight, forming a transparent yellow solution: the rosin is recovered in its original state by evaporation, or is precipitated in form of a white powder by adding water. It is soluble in oil of vitriol, by which it is changed first into artificial tannin, and by further action into charcoal, of which it affords 43 per cent.; whereas it afforded only 0·65 per cent. of charcoal by distillation. Nitric acid also dissolves rosin, and changes it first into a deep yellow viscid substance, and lastly into tannin. Distilled vinegar dissolves rosin, which may be separated from it by water. Rosin is also soluble in a solution of purified pearl ashes, or of purified barilha, as well as in potasse water: these solutions are capable of being used as soaps, and the rosin is separated in a scarcely altered state by acids.

Rosmarini Cacumina.—Rosemary tops have a fragrant, grateful smell, and a warm taste: the infusion is yellowish, with a strong fragrancy and spicy flavour. The distilled oil is limpid like water, with the smell and taste of the flowers: this oil rises also in distillation with spirit of wine. It improves the scent of spirit of lavender, and the compound spirit being impregnated with cinnamon and nutmegs, and coloured with red sanders, is a popular stimulant by the name of lavender drops or red hartshorn. This spiritus lavandulæ compositus is also used in pharmacy to colour the liquor arsenicalis of the Pharmacopœia. Sixty-four grains of white arsenic, and as much true salt of tartar, is boiled in a pint of water, until the arsenic is entirely dissolved; half an oz. measure of spiritus lavandulæ compositus is then added, and the liquor is made to measure a pint exactly by adding more or less distilled water. This is a substitute for a popular remedy for intermittent fevers, called the tasteless ague drop.

Succinum.—Amber, of which the opaque white sort, as being of the least value, is that used in medicine, is a native product, found in mines or washed on the shores, being supposed to be the rosins of forests which have been altered by the sea water overflowing them: when cold it has neither taste nor smell, but when heated it emits a fragrant odour; in a strong heat it burns to ashes. It is not soluble in water, but spirit of wine dissolves by long digestion about one eighth part of the amber, leaving a residuum that is insoluble: the dissolved portion is separable by evaporating the solution to a small compass, and adding water, the precipitate possessing the properties of rosin: oil of vitriol converts it to a black mass; nitric acid first converts it into a rosin-like substance, and then dissolves it completely. It is also soluble in the solution of the fixed alkalies and their subcarbonates. By distillation it yields an oil, which is used pharmaceutically to prepare the spiritus ammoniæ succinatus, the College substitute for eau de luce: this spirit is made by dissolving mastich in spirit of wine, and adding to the clear tincture some spirit of sal ammoniac, and a few drops of oil of lavender flowers and oil of amber, just to scent the compound spirit, and give it an opaque oily appearance.

Styracis Balsamum.—Gum storax has a strong fragrant smell, and a resinous taste, very slightly bitter: on chewing, it is first broken into powder, then united into a mass, which does not stick to the teeth, but is soluble in the spittle, tinging it reddish. When set a-light it burns with a yellowish white brilliant flame, very smoky but aromatic, and leaves a gray ash. By heat alone it does not melt, but the resinous part sweats, and may be pressed out: of this rosin it yields about one sixth, which is brown, sweet smelling, retaining the odour of storax, brittle, growing soft and tough by handling; it is entirely soluble in spirit of wine, forming a yellow tincture, which is rendered opalescent by water. The infusion of storax is yellowish, fragrant, with the taste and smell of storax, scarcely bitterish, and yields a precipitate with green vitriol. The distilled water is opal coloured, sweet scented; the essential oil that comes over first is very small in quantity, sweet scented, deep red, transparent; the second oil is blackish brown, thicker, abundant, equally sweet scented. Distilled by itself it yields the usual products of vegetable bodies, and a small quantity of benzoic acid. This acid may also be obtained by the same method as from benjamin. Storax is soluble in spirit of wine: the solution is rendered white by adding water.

Terebinthina Canadensis.—Common balm of Gilead is of a balsamic, agreeable smell: its taste is mild, very slightly bitter; when chewed it does not dissolve, but sticks to the teeth, lips, and palate. It is superior to the other liquid rosins in appearance, taste, and smell. Distilled with water it yields a limpid, colourless essential oil, and leaves a solid rosin resembling yellow rosin. Distilled by itself it yields first a clear oil resembling that obtained by distillation with water, which gradually becomes yellow, then red, and leaves a black rosin. Balm of Gilead is soluble in spirit of wine: and it is rendered miscible with water, by being previously rubbed with the yelk of egg.

Terebinthina Chia.—Chio turpentine is the rosin of the turpentine tree, and the other liquid rosins having been substituted for it, have of late received that common name of turpentine from the tree which yields this rosin. It is not perfectly transparent, of a yellowish brown colour, with a slight bluish green cast: it is sweet scented, agreeable, somewhat resembling jasmine flowers: its taste is rather fat, bitterish, slightly acrid. Put into warm water it does not melt, but sticks to the fingers if handled, or to the sides of the vessels. In chemical properties it resembles the common balm of Gilead.

Terebinthina vulgaris.—Horse turpentine is thick and buttery, smelling strong of rosin: the taste is rather fat, rosiny, and slightly bitter. The chemical qualities are similar to those of the other terebinthinæ.

Terebinthinæ Oleum.—Spirit of turpentine, as the oil is usually called, is obtained from turpentine by distillation without any addition. Its smell is strong and penetrating; its taste hot, acrid, and bitter. It burns with a very vivid crackling flame: is soluble in hot spirit of wine, but as the solution cools the oil separates; by this insolubility it differs from other essential and volatile oils. It is soluble in ether, and it is converted into a yellow rosin by oxymuriatic acid gas being passed through it. Distilled with four times as much water it becomes lighter and brighter than before. Shaken with an eighth part of spirit of wine, and this repeated with three or four fresh portions of spirit, it is said to be rendered much more pleasant to take. Medically considered it is a specific for the tape worm, acts as a strong stimulant, producing temporary intoxication, succeeded by languor; in some cases it irritates the urinary organs, and produces bloody urine.

Balsamic substances are more stimulant than the farinaceous, gummy, and similar combustible substances. In general they are discutient and resolvent, and used to heal wounds and ulcers. They are of much use in palsy; they stay dysentery and other inward fluxes; they are esteemed as useful in diseases of the lungs, especially their vapour, or their fumes when burned; they are also antiseptic, and some of them are purgative.

Fragrant Substances.—The fragrant substances of the Pharmacopœia are at present but few in number, namely, limonis oleum, omitted indeed in the list of the materia medica, but used in the preparation of the unguentum veratri, moschus, and rosæ centifoliæ petala.

Limonis Oleum.—Essence of lemons is obtained by distillation from the fresh peel; it is limpid, colourless or slightly yellow, sweet scented, agreeable, hot in the mouth. Its chemical qualities resemble those of other essential oils; and from its pleasant smell it is used in pharmacy to hide the odour of sulphur in ointments for the itch.

Moschus.—Grain musk is obtained from a bag in the umbilical region of the musk deer; which in the full sized animal generally contains about two drams of grain musk, the smell of which is extremely powerful and durable, to some pleasant, to others extremely disagreeable. Its taste is rather bitter: it burns with a whitish flame, leaving a light spongy charcoal. The infusion is yellowish brown, bitter, and having the strong smell of the drug; it yields copious sediments with corrosive sublimate, green vitriol, or the infusion of yellow bark; with lunar caustic it gives a white precipitate changing to blue by exposure to light; and with nitrous solution of quick silver yields a precipitate of a brown colour. The tincture is reddish brown, transparent, with scarcely any smell of the musk; but water renders it milky, and the musky odour immediately returns. The ethereal tincture is deep brown, and when mixed with water and the vessel left open, a brown, tough rosin, nearly insipid, but having the characteristic smell of musk, is deposited, while the remaining water is rendered milky. Sulphuric acid and nitric acid dissolve it, but destroy the odour. Rubbed with salt of tartar it gives out a scent of ammonia.

Rosæ centifoliæ Petala.—The flowers of the pale rose have a very fragrant odour, their taste is sweetish, tart, and very slightly bitter. Their distilled water is very odoriferous, and accompanied with a small quantity of white buttery oil called adeps rosarum, having very little smell. The best distilled water usually sold is however obtained by distilling water with attar of roses, that is to say, the essential oil of evergreen roses, which is imported from the hotter countries of the old world, where that rose is very largely cultivated for this purpose.

The fragrant combustibles are used as antispasmodics, particularly musk, which has a very considerable action on the nervous system.

Fetid Substances.—The fetid combustibles of the Pharmacopœia are more numerous, being the following: belladonnæ folia, castoreum, conii folia, galbani gummi resina, hellebori fetidi folia, opium, opoponax, papaveris capsulæ, sagapenum, and tabaci folia.

Belladonnæ Folia.—Belladonna leaves have a slight but disagreeable smell: the taste is nauseous, rather sweet, and slightly acrid: the infusion is mawkish, not altered by green vitriol. It is a powerful narcotic, and the infusion dropped into the eye produces a great dilatation of the pupil.

Castoreum.—Russian castor has a strong, heavy, aromatic smell, and a bitter, nauseous, rather acrid taste. The infusion is yellow, and seems to contain an alkali: the smell and taste are similar to those of the drug; by long digestion a deeper coloured infusion is obtained, which yields on evaporation an extract soluble in spirit of wine and in ether. Spirit of wine dissolves part of the drug; and on evaporation a rosin retaining the smell and taste of castor is obtained. Ether also forms a tincture, and yields by evaporation a similar rosin, which resembles that procurable from bile. Russian castor is ordered by the College, but is scarcely to be obtained; the New England castor is almost always employed; the smell of which is very different from that of the Russian: but its medical effects may perhaps be the same.

Conii Folia.—This name having been given by Linnæus, and the nomenclators of his school, to hemlock, the College have employed it in preference to cicuta, the Latin name of the plant in the works of the fathers of Latin medicine, as well as those who have written on the uses of vegetables, and on the materia medica, by which some confusion has been unnecessarily introduced. Hemlock leaves are fetid, smelling like mice; taste bitter and nauseous. The infusion is limpid, thin, with a weak smell of hemlock; not changed by green vitriol. The expressed juice, evaporated to the consistence of honey, is fetid, bitterish, and rather salt; in summer saline crystals separate from it: during the evaporation, the whole house is infected with the stench of the plant. Hemlock is a very powerful alterative, but it is necessary to begin with small doses, although by use very large ones, as ℥j of the extract, or several pints of the infusion, may be taken daily. Spirit of wine extracts all the medical virtues of the plant, as does also ether.

Galbani Gummi-resina.—Gum galbanum is fetid, bitter; when chewed it grows tough, and at last sticks to the roof of the mouth. Set on fire, it burns with a white flame, smoking very much, and leaves a coal. By distillation it yields a blue oil, inclining to purple. It is purified by being tied in a bladder, melted in boiling water, and then strained. The infusion is bitter, yellowish, with a disagreeable taste and smell. Rubbed with water it forms a white emulsion, but precipitates by standing. Digested in warm water for some time, it forms a soft paste, which becomes hard on cooling. Distilled with water it yields a twentieth part of a yellowish essential oil. Spirit of wine dissolves the resinous part of it; and a mixture of two parts spirit of wine with one of water, makes a perfect solution of it. Vinegar also dissolves it very well. It is said to yield 65·8 per cent. of rosin, 22·6 of gummy matter, 1·8 of cerasine, 0·2 of malic acid, 3·4 of volatile oil, and, as there were found only 2·8 of impurities, 3·4 remain to be accounted for.

Hellebori fœtidi Folia.—The leaves of setter-wort have a fetid smell, a bitter and very sharp taste; when chewed, they flay the mouth, and the taste requires much washing to efface. Vinegar is said to render them milder. They are used, in small doses, as a vermifuge broth for dogs, whence their name, and also for mankind.

Opium.—Turkey opium has a strong, heavy smell, and a bitter, hot taste. When set on fire it burns with a white flame; but the fume has no narcotic smell. Boiling water dissolves about 5 oz. out of a lb. Troy; about 6 oz. are suspended in the liquid, and may be separated by filtering, and the other ounce is left undissolved. This insoluble portion is dark-coloured, viscid, and tough; spirit of wine acquired a yellow colour from it, and became milky on adding water; ether acquired a yellow colour, and left, on evaporation, some rosin, a bitter extractive matter, and some crystals, apparently of morphia: the still remaining residuum resembled gluten of wheat. The clear watery solution of Turkey opium yields a precipitate with any of the carbonates of potasse or soda, with ammonia, corrosive sublimate, nitrate of quick silver, sugar of lead, liquor plumbi acetatis, nitrate of silver, the green, blue, or white vitriols, and the infusion of galls. The infusion yields no precipitate by spirit of wine or acetate of barytes. By long boiling in water, with exposure to air, its narcotic powers are impaired, but nothing arises in distillation with that liquid. The saturated infusion of Turkey opium, boiled with one fiftieth part, in relation to the opium, of calcined magnesia, yields a copious gray precipitate, which being washed with cold water, and warm weak spirit of wine, to separate the extractive matter that colours it, is then boiled in spirit of wine, which being filtered yields, on cooling, white crystals of an alkaline principle, called morphine, or morphia, which existed in the opium, combined with an acid called the meconic, in the state of a supermeconate, and from which it is separated by the magnesia. This meconic acid may be obtained by boiling the infusion of opium with a larger proportion of calcined magnesia, digesting the precipitate in spirit of wine until all the morphia is dissolved. To the meconate of magnesia, that is left undissolved, add sulphuric acid, which dissolves it; muriate of barytes being dropped in, a precipitation of sulphate of barytes and meconate of barytes takes place; this precipitate being digested with weak sulphuric acid, sulphate of barytes is formed, and the meconic acid is left dissolved in the water, from which it may be obtained by evaporation; but as it is still coloured, it must be sublimed with a gentle heat, when it rises in white crystals. Opium yields a considerable part of its substance to spirit of wine, as also to vinegar: the latter solvent diminishes its narcotic powers considerably, without diminishing its sedative and antispasmodic effects in an equal degree. On this account, lemon juice, and the juice of crab apples, have been used to prepare opium for medical purposes. Ether also dissolves a considerable portion of opium, and the ethereal tincture, being evaporated on water, leaves a skin of nearly insipid rosin, but the water is rendered intensely bitter by the extractive matter. The uses of opium in medicine are so extensive, and the administration requires so much caution, on account of its activity, that the writers on medicine must be diligently studied for its use. If an over dose has been taken, a powerful emetic must be given, as white or green vitriol; or the fauces irritated by a feather, or splinter of wood, to promote vomiting. The stomach being thus cleared, water, acidulated with lemon juice, citric acid, or vinegar, should be frequently taken, and the sedative effects guarded against by brandy and other cordials, while the patient is kept awake and in continual motion by the assistance of his friends, the whip, or the application of cowage to his skin: the pouring of warm water over the patient is also recommended for removing the drowsiness.

The combustible alkali, morphia, obtained as above mentioned, is bitter, astringent. It melts in a gentle heat, and in close vessels leaves a solid, rosin-like black mass. It is soluble in 82 times its weight of boiling water; but on cooling the greater part is deposited in crystals. It is soluble in 36 times its weight of boiling spirit of wine, but it requires 42 of cold spirit. Ether takes up one eighth of its weight. It unites with all the acids, and forms salts, which are mostly soluble in water, and capable of crystallizing. A grain of morphia heated with peroxide of copper yielded 3·58 cub. in. of carbonic acid gas, and so much water as contained 2·62 cub. in. of hydrogen; the deficiency, if oxygen, would of course be 1·45 cub. in. whence the composition will be $12\,C + 9\,H + 10\,O$. From its insolubility in water, it has little medical effect when taken in substance; but when dissolved, it acts like opium: acids by combining with it powerfully counteract its effects.

The meconic acid of opium is very soluble in water: the solution is acid, and forms soluble salts with potasse, soda, ammonia, barytes, lime, and magnesia. It strikes a deep red colour with solutions of the peroxide of iron, without any precipitation; and a fine emerald green with blue vitriol, from which solution a pale yellow sediment slowly separates. It also yields a precipitate with corrosive sublimate.

An inferior kind of opium is brought from the East Indies, which resembles an extract; it is entirely taken up by water, leaving no undissolved residuum; the clear solution is deeper brown than that of Turkey opium, is affected in the same manner with reagents, but yields a copious precipitate with acetate of barytes, hence it seems to contain a quantity of sulphate of lime. It yields much less morphia than the Turkey opium, and requires a larger dose to produce the same narcotic effect.

Attempts have been made to manufacture opium in England, but our weather seems too unsettled to allow it to be done to any extent. The English opium has the same extract-like appearance as the East Indian, but is lighter coloured.

Opoponax.—Gum opoponax has a strong smell, and bitter, acrid, lasting taste: when chewed, it breaks, and at length dissolves, rendering the spittle milky. At a candle, it takes fire, and emits a strong scented fume. By rubbing, it forms an emulsion with water, one half being taken up: this solution deposits a resinous matter on standing, and turns yellow. The distilled water smells strongly of the gum, but scarcely any oil separates. Spirit of wine acquires a yellowish colour from this gum, along with its smell: the distilled spirit has also the same scent. It is resolvable into gum, rosin, starch, extractive matter, wax, malic acid, Indian rubber, and essential oil.

Papaveris Capsulæ.—Poppy heads have a heavy, disagreeable smell; their infusion, the seeds having been previously removed, is red, with a disagreeable smell, and a weak, mawkish taste; it is rendered darker by green vitriol. By evaporation, an extract is obtainable, which is milder in its action than opium.

Sagapenum.—Gum sagapenum has a very strong smell, and an acrid, bitter taste; when chewed, it sticks to the teeth, becomes white, and then dissolves, rendering the spittle white. At a candle it takes fire, does not drop, burns with a large, high, smoking flame, with a strong smell. Heated in a vessel, it does not melt, but exhales first a scent like garlick, then that of assafetida, and consumes away without flame, leaving a black coal dirtying the hands. Rubbed with water it forms a dirty yellow solution. Distilled with water, a little essential oil and a strong-scented distilled water is obtained. Spirit of wine dissolves about half of it; the tincture is red, not strong smelling; on adding water, it becomes milky, and the smell of the gum is more perceptible.

Tabaci Folia.—Tobacco cuttings have a strong narcotic smell; they are bitter, and rather acrid; when chewed, they slightly bite the tongue, and render the spittle green. The powder excites sneezing. In the flame of a candle they take fire, and burn with a narcotic fume, which, although disagreeable at first, becomes grateful by use. Thrown into the fire, they sparkle and crackle like salt petre, especially the foot stalks and ribs. The infusion is reddish, and grows brown with green vitriol; swallowed, it is emetic. Distilled with water, it yields no essential oil; but distilled by itself, it yields a greenish oil, which is highly deleterious to animal life; a single drop instantly killed a snake. A peculiar principle, called nicotine by Vauquelin, may be extracted from tobacco, by the repeated action of water and spirit of wine, distilling each time to dryness, after the addition of potasse to saturate the malic and acetic acid, which are combined with this principle. This principle is colourless, acrid, occasioning violent sneezing; it is soluble both in water and spirit of wine, and is considered as belonging to the class of volatile oils.

Fetid combustible substances are in general narcotic, but their medical action being considerable, they vary too much to be substituted for one another. They seem to differ from the fragrant substances, by having their principles in a more concentrated state: for we see that many substances, as musk, are fetid when held close to the nose, but fragrant when sufficiently distant.

Fat and oily Substances.—The seventh class of compound combustible bodies is composed of the fat oily substances. Those enumerated in the Pharmacopœia are now reduced to a few only, namely: adeps, cetaceum, olivæ oleum, ricini oleum, sapo durus, sapo mollis, and sevum; to which will probably be restored in a future edition, the crotonis oleum, which has been omitted of late years.

Adeps.—Pigs flare is used only to prepare lard, and as the apothecaries always purchase it in the latter form, it does not appear why the flare should stand in the list of drugs. The adeps præparata, or lard, melts at 97° Fahr. It does not dissolve in water, but when melted therewith it absorbs a certain quantity; this hydrated lard grows rank much sooner than the pure. It does not dissolve in spirit of wine without a boiling heat. The solution, as it cools, deposits crystals which are stearine, and the supernatant tincture being distilled, leaves the other oil-like principle of fats, called elain. By this means the lard is resolved into 62 per cent. of elain, and 38 of stearine. The stearine is white, brittle, and resembles wax; it requires a heat of 109° Fahr. to melt it. The elain resembles vegetable oils, and is liquid at 59° Fahr.; it is soluble in 81·03 per cent. of spirit of wine. Both form soaps with the alkalies, leaving a portion of the sweet principle of oils. Nitric acid added to lard renders it yellow and harder than before. With liquor potassæ it forms a soap partly soluble in water, partly depositing pearly scales of margarate of potasse, decomposable by spirit of salt, and thus yielding margaric acid, as it is called, although it resembles wax, and is not soluble in water. The dissolved portion is an oleate of potasse, and being decomposed by tartaric acid, yields what is called the oleic acid, resembling an oil; but both these substances redden blue vegetable colours like the common acids.

Cetaceum.—Spermaceti is principally obtained from the head matter found in the skull of the spermaceti whale; the oil mixed with it is separated by straining or repose, and finally by soap lees. It melts at 112° Fahr.; by a greater heat it may be distilled, but by a repetition of this process it loses its beautiful crystalline appearance and becomes a liquid oil, an acid liquor also making its appearance. Soluble in spirit of wine, but separates as the solution cools. Ether dissolves it; if the solution was made with heat, it concretes on cooling. Oil of turpentine, when hot, also dissolves it; but it separates on cooling. With liquor potassæ it forms a soap which is partly robbed of the alkali by water. When this soap is decomposed by an acid, the spermaceti is changed into a white solid substance, no longer crystallizing in plates, and called cetic acid, although not soluble in water, but from its action on vegetable blues. Ammonia forms an emulsion with spermaceti.

Olivæ Oleum.—Sweet oil being employed in medicine almost entirely for ointments and plaisters, the inferior oil obtained from ripe olives, sweated in heaps to increase the yield at the expense of the quality, is used; as also second olive oil, expressed from poppy seeds. Sweet oil is yellow, more or less deep; smell, when pure, none, by which the admixture or substitution of poppy oil is known, the latter having a very discernible smell. The taste is mild, but by exposure to air it grows rank. It freezes at 53° Fahr. according to Bergius, unless it be rank, and then near the freezing point of water: but these experiments having been made on this side the Alps and Appennines, cannot be depended upon, as the oil might be poppy oil, or mixed with it. It burns, by means of a wick, with a bright flame, and yields, if pure, scarcely any soot or bad smell. Digested in a moderate heat for a fortnight, it lost scarcely any thing of its weight; at a greater heat it emits watery vapours, grows thick, and then soon catches fire. Distilled by itself, it yields an acid liquor, and then an acrid oil, soluble in spirit of wine, but little charcoal is left. If the oil is mixed with brick dust or sand before it is distilled, the oil that comes over is very stinking. Sweet oil is not soluble in spirit of wine; it is rendered miscible with water, by the yelk of egg, or by rubbing with gum Arabic powder. Ether dissolves rather more than a quarter of its bulk of sweet oil. Sweet oil left in contact with liquor potassæ, unites by degrees and forms a compound called soap; the solution of which in water is decomposed by any acid. Sweet oil boiled with litharge, 5 lb. to the gallon, along with some water, unites with the oxide of lead, and forms the emplastrum plumbi, which is the basis of several other diversely medicated plaisters: the residual water, on evaporation, leaves a sweetish substance called Scheele's sweet principle of oils. This sweet principle may be obtained from most oily bodies; it does not form crystals, is soluble in water, and also in spirit of wine, and when treated with nitric acid it is converted into oxalic acid. Sweet oil also dissolves sulphur by boiling, forming the oleum sulphuratum, usually called balsam of sulphur. United with lard, wax, rosins of various species, spermaceti, it forms various kinds of ointments, liniments, and plaisters, some of which are again medicated with other drugs.

Ricini Oleum.—Castor oil is best obtained from the seeds of palma Christi, by expression, by which they yield about one quarter of their weight. It has but little smell or taste at first, but leaves a slight acrimony in the throat. Its chemical characters resemble those of sweet oil, but it is miscible in any proportion with spirit of wine; hence it is used to lower the price of the more costly essential oils. It is also miscible with ether in any proportion.

Sapo durus.—Castille soap is that ordered by the College under this name. It is a composition of sweet oil and soda, marbled by the addition of a little green vitriol: on which account, the older editions of the Pharmacopœia ordered the apothecary to prepare the hard soap himself, without this metallic salt, and most dispensing practitioners use English soap, which is white but made from tallow. Soap is soluble in water, but the solution is opal coloured. This solution, which is remarkable for the large bubbles, or lather, it forms when agitated, is decomposed by all the acids, which uniting with the soda, separate from it the oleic acid in an oily form: by this analysis, pure hard soap is found to be an oleate of soda, with from 25 to 50 per cent. of water. The earthy salts, as sulphate of lime, and others, usually present in spring water, decompose soap, by exchanging their bases, the earthy oleates thus produced separating in the form of curds; but the alkaline salts do not curdle the solution of soap, nor affect its lathering in the least. Spirit of wine dissolves soap perfectly, but on adding water, the solution becomes milky and is partly decomposed.

Sapo mollis.—The best crown soft soap is said to be made from tallow, hogs lard, and olive oil, formed into a soap with a ley drawn from Dantzic pearl ashes with an eighth of kelp; and the second crown soft soap of tallow and whale oil, with a similar ley, the water not being drawn off, but retained in the soap. The soap usually employed has numerous seed-like spots of tallow diffused; but on melting with a gentle heat, they disappear, and the soap becomes homogeneous. Soft soap is seldom used, and might well be spared from the materia medica of the College; when originally inserted, it probably meant what our ancestors called sweet soap, made of Dantzic soap ashes and olive oil; but which is no longer manufactured, unless by perfumers under some other name, I believe under that of Naples soft soap.

Sevum.—Although mutton suet is meant by the College by this term, yet the use of the rendered suet, or sevum præparatum, is mostly confined to the perfumers for their hard pomatums. The employment of tallow for giving consistence to ointments, instead of rendered mutton suet, is almost universal among the makers of them. The old editions of the London Pharmacopœia not only distinguished sevum ovinum and sevum bovinum, but even made a separate article of sevum vaccinum. Although a manifest difference exists between good ox beef and cow beef, there may be reason to doubt whether any exists between their tallow. It differs little from lard except in its more solid consistence; and like that fat consists of stearine and elain.

Crotonis Oleum.—Oil of croton is extracted from Molucca grains or purging nuts, the seeds of the croton tiglium of the Linnæan botanists. In its chemical qualities it probably agrees with castor oil, but is considerably more active, a single drop, when the oil can be obtained genuine, being a powerful cathartic; but like all other oils it is so reduced during its passage through the various dealers' hands, that it has frequently disappointed the practitioner, and thus affords another instance of the superior prudence of the old practitioners in their preference for native articles. Dr. Nimmo has proposed to digest the oil with spirit of wine previously heated upon olive oil that it may be saturated with fixed oil: the oily residuum, not taken up by the spirit, ought to be 55 per cent. of the raw oil, which contains 45 per cent. of an acrid principle resembling elatine.

Oily and fat substances are in general emollient; hence they are useful, externally, in inflammations, bruises, and wounds, attended with pain and distention, in dryness of the fauces, and contractions of the limbs; and internally, in pleuritic and colicky pains, strangury, and pain after child-bearing. Both externally and internally, they lubricate the parts, are demulcent, and mitigate acrimony; hence they are serviceable in cases of poisoning, in canine appetite, in acrid stools, and used in glysters, in tenesmus, and the bloody flux. When rank, they discuss tumours and promote suppuration. Oily substances are useful in coughs, catarrhs, and consumptive diseases: they are all more or less purgative, and in large doses emetic; hence they are given in worm cases. On the other hand, as they close the pores of the skin, they are hurtful in inflammation, unless the pain and tension is great. As they prevent drying, they render ulcers foul, increase the ichorous discharge, and favour the progress of caries in the bones, and of fungous flesh. Their internal use, if excessive, encourages the generation of wind.

Sweet Substances.—The eighth class of compound combustible substances are the sweets. Those in the Pharmacopœia are amygdalæ dulces, caricæ fructus, cassiæ pulpa, glycyrrhizæ radix, dauci radix, manna, mel, pruna, rosæ caninæ pulpa, saccharum, saccharum purificatum, and uvæ passæ, to which may be added milk.

Amygdalæ dulces.—Almonds boiled in water yield a white fat, swimming on the decoction, which last is thick, opalescent, and not altered by green vitriol. By expression they yield half their weight of a fine very pale yellow oil, mild to the taste, but soon growing rank, especially if pressed with heat to increase the yield of oil. Rubbed with water they form a white milky liquid called an emulsion, resembling the milk of animals. Five eighths are thus dissolved, the remaining three remain on the filter, and when dry are a grayish coarse powder. The emulsion being left at rest, a white cream rises to the top; in summer-time it soon turns sour; it yields a precipitate by acids, but not a curdy mass like milk. The emulsion heated gently, does not part with its oil, but a thin skin of cream arises, and by evaporation, the whole is reduced to a gray, very soft, fat mass, soluble in water, forming a milky liquor which lathers on agitation; if hot water is used for this solution, drops of oil appear, otherwise not. Emulsion of sweet almonds does not ferment well. One lb. rubbed with 2 gall. of water, and 6 spoonfuls of yeast added, fermented for three days, yielded on distillation 3 lb. of a clear, rather opaline, grateful, spirituous liquor, with the smell and taste of the almond.

Caricæ Fructus.—Figs yield a reddish, rather thick, sweet infusion, with the smell and taste of the dried fruit; not altered by green vitriol. This infusion, as also the decoction of figs, ferments when placed in the sun. By degrees, the saccharine matter of figs exudes from them, and they lose their sweet taste, become first bitter, and then putrescent. This saccharine matter is soluble in water, but Bergius could not obtain crystals of sugar from it.

Cassiæ Pulpa.—The pulp of the pudding pipes is obtained by bruising that fruit, washing out the pulp with a little water, and then reducing it by evaporation to a proper consistence; they yield about one fourth of their weight. The pulp has a sickly smell, and a sweet mucilaginous taste; it turns sour very speedily, especially in summer, but by the addition of a twentieth part of honey, this may be in some measure prevented. The infusion is deep brown, precipitated by spirit of wine, by sugar of lead, and by oxymuriatic acid, which throws down a yellow precipitate, not soluble in ether; but the infusion is not altered by nut galls, nitrate of silver, green vitriol, nor by the sulphuric or nitric acids. Spirit of wine dissolves only part of the pulp; the tincture does not yield a precipitate on adding water, but leaves a small quantity of rosin on evaporation.

Dauci Radix.—Carrots have an aromatic, and not unpleasant smell; their taste is sweet. The expressed juice of the root is extremely sweet, and resembles honey, but does not furnish crystals of sugar. The infusion is of a fine reddish colour, with an aromatic, pleasant taste; it is not changed by green vitriol. The decoction being evaporated yields a kind of honey; or being fermented, it yields a spirituous liquor, which, by rectification, is concentrated into spirit of wine.

Glycyrrhizæ Radix.—Stick liquorice has scarcely any smell, but tastes very sweet; on chewing, it softens and turns into a stringy pulp. The infusion is yellowish, very sweet; its colour is not changed by green vitriol, but it is rendered turbid. The first infusion gave, on evaporation, a yellowish, sweet, pleasant extract; that of the second infusion was darker, and less sweet. The residuum boiled in water gave a black extract, with a sharp taste, and very little sweetness. The decoction of it is rather sharp and nauseous; whence the root, when used to sweeten decoctions, should be only put in at the end.

Manna.—Manna is collected from the manna ash, principally in Calabria. The tear and flake manna exudes spontaneously in June and July; when this ceases to be formed in August, incisions are made in the bark, and the inferior manna is collected. Manna has no smell, but is sweet and mawkish; when chewed, it breaks down, and is soon dissolved. At a candle manna melts, crackles, does not take fire but drops, with a smell of burnt sugar; which it then resembles, but is softer and rather tough, adhering to the teeth. In a ladle, it melts, froths, takes fire with difficulty, then burns with a low blue flame, little smoke, a fragrant smell of burnt sugar, leaving a very light cone of black rough charcoal, dirtying the hands. It dissolves in water; the solution is limpid, slightly yellowish, sweet, not altered by green vitriol, nor by spirit of wine. Hot water dissolves an equal weight of manna, but as the solution cools, five eighths of it separates in crystals, which may be regarded as pure manna: an uncrystallizable mucilaginous extractive matter is left in solution. Spirit of wine also dissolves manna, the solution is clear; but if heat is employed, the solution forms as it cools a soft, buttery, very white mass, resembling lard, which is very sweet; on drying, this becomes still whiter, and is easier dissolved in cold water than manna itself.

This is not the manna of the Jewish historians; that being the exudation of a species of tamarisk, growing in certain parts of Arabia; which is only to be collected at early dawn, as the heat of the sun melts it, so that it runs into the sand and becomes invisible. It exudes in June, but only in rainy years; it is white, solid if kept in a cool place, but melts even by the heat of the hand; its taste is sweet, and somewhat aromatic. It is very scarce.

Mel.—Honey varies much in its medical effects according to the plants from whence the bees collect it, being in some places poisonous. The white English honey is usually preferred for internal use, and East country, that is to say, Russian honey, is thought good enough for external. The best honey has an aromatic smell, and a sweet, yet sharp taste. Heated, it throws up a scum, which being taken off, the remaining honey is less apt to ferment than the crude. It is soluble in water; the solution being fermented yields a vinous liquor, called metheglin, or mead. The acid of the honey being neutralized by chalk, the solution, on evaporation to a proper point, affords crystals of sugar. Spirit of wine also dissolves honey, and sugar may be obtained in crystals from this solution. Nitric acid converts honey into oxalic acid.

Pruna.—The common black prunes are those intended by the College, as appears by the use of them in making the confectio sennæ. They have a weak smell, and a sweet, slightly acid taste: they dissolve almost entirely in the mouth, leaving only the stone and skin.

Rosæ caninæ Pulpa.—Hips are slightly acid; when chewed, they break down, and tinge the spittle red; when boiled, they become more tender, and acid; the decoction is reddish. The hips of the different species of roses, included under this Linnean name, vary in flavour; hence the conserve made of them varies also, and is sometimes so fine flavoured, as to be worthy of a place in a dessert.

Saccharum.—This general term is restricted by the College to the coarser cane sugar, called raw, muscovado, or brown sugar; a lb. of which is in general yielded by each gallon of cane juice, by boiling with a little lime to get rid of the acid that would otherwise impede its concretion into crystalline grains. When this coarse sugar is required to be purified, it is dissolved in lime water, clarified with blood, which coagulating involves the impurities and allows them to be skimmed off, then boiled down to a proper consistency, very slowly cooled, and the uncrystallized part or treacle allowed to drain off by a hole in the bottom of the vessel, and the remains washed out by the gradual supply of water, percolating through moist clay spread over the surface: by which chain of operations it is rendered white and hard. The coarse sugar is used by apothecaries as a substitute for the refined, in making the conserves and syrops, which are of a dark colour. A little brown sugar added to flour paste, which has been prevented from growing mouldy by the addition of cloves, or some strong smelling oil, renders it easily soluble again in water, if it dries by being kept in an open vessel. The same addition is also made to glue, to render the cake so soluble in water as to require only wetting and rubbing on the things to be joined; in which state it is called mouth glue. Added to common ink, it not only prevents it from drying too quickly, but also, by rendering the dried writing in some degree soluble in water, enables it to be taken off on a damped sheet of silver paper by pressing them strongly together.

Saccharum purificatum.—Refined sugar has no smell, but a strong sweet taste; when two pieces are rubbed together, light is emitted, which is visible in the dark. It is not altered by exposure to air. When heated, it melts, swells, turns brownish black, froths, and exhales a peculiar smell: in a strong heat it instantly takes fire with a kind of explosion; the flame is white with a blue edge. On distillation, 480 grains of sugar yielded 270 gr. of an acid called the pyromucous, a drop or two of empyreumatic oil, and 120 gr. of charcoal, with 41 oz. meas. of carbonic acid gas, and 119 oz. meas. of carburetted hydrogen gas, weighing conjointly 90 grains. The pyromucous acid, on saturation with potasse, did not evolve any ammonia. Sugar is soluble in an equal weight of cold water, but at the boiling point they unite in any proportion. A concentrated solution, cooled very slowly, crystallizes, and is called white sugar candy. Spirit of wine dissolves only one sixteenth of its weight of sugar; on standing, it separates in beautiful crystals. It unites readily with oils. Sulphuric acid, and muriatic acid, dissolve sugar, convert a part into charcoal, and the remainder is not crystallizable. Oxymuriatic acid converts sugar into an acid called the malic, and is itself changed into common muriatic acid. Nitric acid dissolves sugar; nitrous gas being emitted, and the sugar converted into oxalic acid: 480 gr. of sugar, with 6 oz. of nitric acid, and as much water, yielding 280 gr. of oxalic acid. Vinegar, and tartaric acid, deprive sugar of the power of crystallizing. The composition of sugar is supposed to be $6\,C + 5\,H + 5\,O$.

Oxalic acid is crystallizable, in 4-sided prisms; it is soluble in its own weight of boiling water, or twice its weight of cold water. The liquid acid is very acrid when strong, but of an agreeable taste if diluted; a large dose proves almost immediately fatal, as has happened too often, it having, from its resemblance to Epsom salts, been taken by mistake for them, especially as it is in very common use in England to cleanse boot tops: but as the solution immediately discolours common ink, it is, by this means, readily distinguished. It decomposes all the salts of lime, separating from their solution an insoluble oxalate of lime. Its composition is disputed: Berzelius makes it $24\,C + H + 36\,O$, or rather, $12\,(2\,C + 3\,O) + H$; Thomson, conceiving the hydrogen to be derived from water obstinately retained by the acid, considers it as only $2\,C + 3\,O$.

Malic acid is not crystallizable; when heated, it sublimes in needle-like crystals, and its properties are altered. It forms with lime a soluble salt, which is decomposed by citric acid; dropped into a solution of pearl ashes, crystals of cream of tartar are not deposited.

Sugar is used in pharmacy to preserve a number of vegetable substances, either when dissolved into a syrop, usually made of 2 lb. avoird. of loaf sugar to the pint of water; or in a solid form, by merely beating up the vegetable substance with about three times its weight of sugar, as in the various confections, formerly distinguished into conserves, when only a single substance was thus preserved; and electaries, when a number of drugs, with their adjuvants to assist their operations, their correctors to get rid of any ill effects expected from them, and their dirigents to determine their action, were all beat up together. Sugar is also used in the London Pharmacopœia to sweeten the infusum rosæ, which is merely very dilute sulphuric acid, coloured with the petals of the red rose, to give it a medicated appearance: but these two additions promote its spontaneous alteration, and are therefore not only superfluous but hurtful; and sometimes for suspending or promoting the solution of resinous or similar substances in water: as when essential oils, or essences, as the mixture of these oils with spirit of wine is called, are dropt on sugar, and then dissolved, or mingled with water. So also musk is rubbed with gum Arabic and sugar, to keep it suspended in the mistura moschi. In like manner myrrh is ground with sugar and salt of tartar to dissolve it more completely in rose water, and spirit of nutmegs, in making the mistura ferri composita, or Dr. Griffith's myrrh mixture. To this solution is then added green vitriol, which is decomposed by the carbonate of potasse; the acids exchanging their bases: the sulphuric acid of the green vitriol leaving the protoxide of iron to unite with the potasse of the salt of tartar, and thus remains dissolved in the liquid; while the protoxide of iron unites with the carbonic acid thus set free, and forming a green hydrated carbonate of iron, is kept suspended for some time in the solution of myrrh. As this carbonate rapidly absorbs oxygen from the air, and is thus converted into red oxide, letting go the carbonic acid, this preparation cannot be kept; it must be made when wanted, and each dose ought to be immediately put into a phial no bigger than will just hold it. Being an excellent tonic, it merits these precautions.

Uvæ passæ.—Raisins contain sugar, mucilage, jelly, albumen, gluten, and cream of tartar, along with the tartaric, citric, and malic acids, the sugar being the predominant principle; they are used to sweeten a few preparations of the Pharmacopœia, as barley water, tincture of senna commonly called Daffy's elixir, and the compound tincture of cardamoms. Raisins are used by military officers as a very convenient viaticum in excursions to places where houses of entertainment are not to be met with.

Milk.—Cow's milk, by standing, throws up a thick cream, the remaining skimmed milk is of a blueish white colour, and on being heated with a little rennet, which is an infusion of the inner coat of a calf's stomach preserved by salting, it coagulates, and on breaking the curd the fluid part, or whey, very soon separates from the curd, which by pressure forms a solid mass called cheese. Milk left to itself turns acid, but does not putrefy, even when kept for months in an open bottle. If the cream, as its separates, is beat down into the remaining milk, this ferments, and yields by distillation, a spirit like that of wine. Milk may be coagulated without the previous separation of the cream, and in this case the cheese is so much the richer; still better cheese is made by adding cream skimmed off one portion of milk to a similar portion of new milk, or even less, before the coagulation. Milk may also be coagulated by all acids, and the infusion of the flowers of artichokes and thistles, as also by spirit of wine; but if the milk is diluted with ten times as much water, it is no longer coagulable.—Cream, by agitation, is converted into butter, and a watery liquid called butter milk, which last by evaporation yields sugar of milk in crystals. If the cream is left to itself in a flat vessel it becomes solid, and its surface is covered over with various species of fungi, in which state it is, from having acquired the taste of very fat cheese, called cream cheese.—Butter by a gentle heat melts, a little curd and whey separate from it, and the remaining clarified butter assumes the appearance of oil, but with the loss of its agreeable flavour.—Curd nearly resembles gelatine or albumen, but contains some of the creamy part of the milk, which according to its quantity gives various flavours to the cheese made from it. If the curd is broken, and the whey separated from it by a strong pressure, the cheese is poor, and the whey excellent for food; but if the curd is left unbroken and the whey separated by a very gentle pressure, or even none, the cheese is good, but the whey is thin and watery.

Human milk contains only one third as much cream, one sixth as much curd, but twice as much sugar as cow's milk.

Asses milk contains only half as much cream or curd, but more than three times as much sugar as cow's milk.

Goat's milk contains three times as much cream, once and an half as much curd, and only two thirds as much sugar as cow's milk.

The substances of this class, namely the sweet combustibles, in general are not capable of being distilled unchanged; they are highly nutritious, and hence useful to persons who are reduced in flesh. They are also emollient, smoothening, laxative, and obtund the acrimony of the secretions; hence they are pectoral, and useful in coughs, colds, hoarseness, and heat of urine. Sweets are antiseptic, particularly honey and sugar, and at the same time cathartic and diuretic. They easily run into fermentation, as well within as without the body; and are thus apt to turn sour in the primæ viæ, and produce belching, looseness, and even vomiting. They are improper in dropsical and hypochondriac disorders, as occasioning obstruction in the smaller vessels by their fattening quality.

Acrid and salt Substances.—The ninth and last class of compound combustible bodies is that of the acrid and salt substances. A number of these are enumerated in the London list of the materia medica, and they may be divided into two subdivisions, according to the intensity of their acrid or saline qualities.

Strong Acrids.—The stronger acrids are aconiti folia, ærugo, allii radix, ammoniacum, armoraciæ radix, asari folia, assafœtidæ gummi-resina, cajuputi oleum, camphora, capsici baccæ, colchici radix, dolichi pubes, euphorbiæ gummi-resina, guaiaci gummi-resina, hellebori nigri radix, lyttæ, mezerei cortex, pimentæ baccæ, piperis longi fructus, piperis nigri baccæ, porri radix, pulegium, pyrethri radix, ricini semina, rutæ folia, sabinæ folia, scammoneæ gummi-resina, scillæ radix, senegæ radix, sinapis semina, staphisagriæ semina, toxicodendri folia, veratri radix, zingiberis radix; to which may be added cubebæ, and secale cornutum.

Aconiti Folia.—Monk's hood leaves, which are ordered by the College as a substitute for the aconitum recommended by Stoerk, have, when fresh, a faint smell, and a bitter, acrid taste; but much of the smell and taste is lost by drying. The juice of the fresh leaves is dark red, smell ungrateful; taste acrid and slightly styptic; on evaporation, it becomes rather saltish.—The aconitum of Stoerk is supposed by Bergius to be the a. cammarum, because the powder of this plant is very acrid, and impresses a lasting heat on the tongue, as described by Stoerk; but Willdenow, from botanical considerations, thinks a. Neomontanum was used by that physician. In truth, to pursue Linnæus' analogy of sexual generation in plants, we might say, that the genus aconitum, like some families of mankind, seem a very adulterous race. His a. napellus is now divided into, or confounded with no less than 18 species; the case is the same with a. cammarum, a. lycoctonum, and a. Neomontanum; so that it seems almost impossible for an apothecary to be certain what plant he uses.

Ærugo.—Verdigris is principally manufactured by the farmers' wives and daughters in the South of France, to procure pocket money, by laying plates of copper among the cake left on pressing grapes for wine; the cake being moistened with water or bad wine. Once a week the copper is taken out, the verdigris scraped off, pressed into cakes and dried. Verdigris is also prepared by moistening copper with distilled vinegar, or vinegar of wood. When not pressed into a mass it is in needle-like crystals, silky, and of a light blue colour. It has no smell, seems at first insipid, then remarkably styptic, leaving a strong metallic taste in the mouth. Water divides it into a binacetate of copper, which is taken up by the water, and leaves 44 per cent. of an insoluble subacetate mixed with any accidental impurities. Verdigris consists of 43 per cent. of peroxide of copper, 29 of acetic acid, and 28 of water. It is used externally, as an escharotic and detergent. Sugar diminishes its solubility, and should be given in cases where an over dose of verdigris has been taken.

Allii Radix.—Garlick is the bulb of the garlick plant. It has a pungent, offensive smell, and an acrid, biting, yet sweetish taste; when chewed, it renders the breath very strong smelling for a long time. The juice rubbed between the fingers until dry, makes them shine; if rubbed on white paper it renders the paper stiff and transparent, as oil would. By boiling in water, garlick loses its stench, is rendered sweeter, and acquires the smell of onions; as does also the decoction, which retains the taste, is turbid and thick, but not glutinous; on adding green vitriol, the colour remains, but a mucilaginous matter falls down; and the same happens on adding spirit of wine to the decoction. 6 lb. of skinned cloves of garlick yielded a dram of very strong-smelling yellow essential oil, that sunk in water. Spirit of wine extracts a reddish yellow tincture, which leaves, on evaporation, a very acrid, brown, resinous extract, that grows moist by keeping.

Ammoniacum.—Gum ammoniac has a strong, disagreeable smell, a bitterish, rather acrid taste, which is retained for some time by the mouth. On being chewed, it softens, sticks slightly to the teeth, particularly the white kernelly part, becomes white, and is dissolved, tinging the spittle milky. At a candle, it takes fire, softens, some of it drops, and throws out sparkles; the flame is very bright and smoky. In a ladle, it melts, boils, takes fire from a flame brought near it, and leaves a hollow, black, shining, dry charcoal, that scarcely dirties the hands. It is partly soluble in water; the solution is milky, and deposits on standing a rosin. If merely left in water, it becomes soft, and very white, like the curd of whey. Distilled with water, it gives a slightly scented water, and no essential oil. It dissolves in the same manner in wine and vinegar. Spirit of wine dissolves half; the tincture is very limpid, and smells but weakly of ammoniac; on adding water, it turns white, and the smell of the gum becomes more sensible, but very little falls down. Lintseed oil does not dissolve gum ammoniac, nor is it tinged by it. Oil of turpentine renders it softer, and becomes of a deep yellow. Ether takes up 60 per cent. leaving a gum which possesses the taste of the gum ammoniac; the solution on evaporation yields a yellowish, white, insipid rosin. By a late analysis, it is said to contain 70 per cent. of rosin, 28·2 of gum, 4·4 of mucilage, and 6 of water, 1·2 being lost. The rosin is changed by nitric acid into a yellow matter that dyes silk of that colour.

Armoraciæ Radix.—Horse radish is strong smelling and makes the eyes water; its taste is hot, acrid, sweetish, yet often rather bitter; when chewed, it bites the tongue, causes coughing, sneezing, and the eyes to water; when boiled, it becomes mild, sweetish, and with but little scent; by drying, both its smell and taste is weakened. The infusion is precipitated by sugar of lead, and nitrate of silver. The distilled water smells strongly of the root; the essential oil is pale yellow, heavier than water, extremely pungent in its smell, and of a very acrid taste. Starch may be extracted in small quantity from this root. Spirit of wine distilled from it carries over much of the pungency.

Asari Folia.—Asarabacca leaves have no smell, but a slightly aromatic, nauseous, rather acrid taste; when chewed, they slightly heat the throat. The powder causes violent sneezing. The infusion is deep red, tastes rather sharp, and is turned very dark brown by green vitriol, a grayish sediment falling down.

Assafœtidæ Gummi-resina.—Gum assafetida was called by the ancients, opium Cyreniacum, or juice from Cyrene; its present name having been given it by the Jewish school of medicine at Salerno. It has a most stinking, garlick-like smell; the taste is bitterish, acrid, biting, lasting long in the mouth, even although it be washed with water, vinegar, or spirit of wine. When chewed, it is first tough, then dissolves, colouring the spittle white like cream, and dyeing the tongue and palate also white. Rubbed with water, it forms a milk-like liquid, about 60 per cent. being really dissolved, which is not gummy but extractive matter. Digested in water, it first becomes white, and infects the place with its nauseous smell for a couple of days, in spite of ventilation; but by degrees it is reduced to a chalk-like mass. The solution is of a dirty yellowish colour. The distilled water is stinking, the essential oil, of which it yields about 10 per cent. is still more stinking. Spirit of wine dissolves about three quarters of this gum; the tincture is yellow and stinking. The ethereal tincture, being evaporated on water, leaves a skin of brown stinking rosin, and the water is rendered milky. The spiritus ammoniæ of the Pharmacopœia, impregnated with an ounce of assafetida to the pint, is ordered by the name of spiritus ammoniæ fœtidus.

Cajuputi Oleum.—Cajuput oil has a strong smell, which when diffused through a house is very pleasant. Its taste is pungent, and somewhat like that of camphire. Dropped upon water it diffuses itself very quickly on the surface, and soon evaporates away. It burns rapidly. It is partly soluble in water. Spirit of wine dissolves it completely. Its green colour is said by some to be derived from the copper flasks in which it is imported; but by others, to belong to it.

Camphora.—Camphire is mostly obtained by splitting a tree, and picking out this concrete volatile oil, which is found in the heart of it: after which this crude camphire is refined by sublimation. Camphire has a strong, fragrant smell; the taste is bitter, very hot, and pungent. When chewed, it does not dissolve, but heats the tongue and throat. It is extremely volatile, subliming spontaneously, and crystallizing on the side of the bottle which is next the light. If heat is applied, it melts and sublimes in a solid lump; but if camphire is ground with bole, and then distilled, it is changed into a liquid oil, a butter-like sublimate, and some charcoal is left. Camphire takes fire at a candle, and burns with a very large, yellowish, white flame, very smoky, having a rather bituminous smell, and leaving no coaly residue; if the flame is put out by dropping the camphire into water, it is found not to be altered, but still retaining its original whiteness. Thrown upon burning charcoal it flies away in fume, without flaming, neither does it take fire in the focus of a burning glass. Water, especially if it contains any carbonic acid, dissolves a small portion of camphire, and retains it although the vessel be left open for a week. Rubbed with mucilage, yelk of egg, or blanched almonds, it may be suspended for some time in water, but on standing it separates. Lemon juice also dissolves a small quantity of it. Spirit of wine dissolves about three quarters its weight of camphire: if more be added, the greater part remains at the bottom, but some part floats more or less high in the spirit, in the form of a feathery plume; the variations in which are said to foretell the weather, although the vessel be perfectly close. Sulphuric acid dissolves camphire, changes it first black, and then into a yellow oil, a species of tannin, and charcoal. Nitric acid also dissolves camphire, the solution floats in the form of a pale yellow oil on the remaining acid: the camphire is recoverable from this acid by adding water. Vinegar takes up a little camphire; and the strongest acetous acid a more considerable portion. It is not soluble in alkalies; but it is soluble in sweet oil as instanced in the linimentum camphoræ, and also in oil of turpentine. The volatile alkali is used in pharmacy to acuate the spirit of lavender, and camphire being dissolved in this acuated and aromatized spirit of wine, forms Ward's essence for the headache adopted by the College, and named by them linimentum camphoræ compositum.

Capsici Baccæ.—Guinea pepper has a spicy narcotic smell; its taste is extremely hot; when chewed, setting the mouth as it were on fire, or as if pierced by ten thousand needles; and this fiery taste lasts a long time. The powder also affects the throat and eyes very much. The infusion is reddish, rather thick, very fiery to the taste; green vitriol does not alter its colour, but it concretes into a jelly, as it does also on adding spirit of wine. Nitrate of silver, corrosive sublimate, sugar of lead, white vitriol, blue vitriol, and salt of tartar, also produce a precipitate with it; but not the sulphuric, nitric, nor muriatic acids, potasse water, nor liquor of flints. Spirit of wine extracts an acrid tincture from Guinea pepper; but when distilled off, the spirit passes over deprived of this pungency, which remains in the rosin. The ethereal tincture, when evaporated on water, leaves a similar orange colour acrid rosin, which has been lately considered as a vegetable alkali, by the name of capsicine.

Colchici Radix.—The dried bulbs of meadow saffron have no smell, and their taste is bitter, although sometimes sweet: the powder is a light fawn colour, which if good, changes to a blue on being rubbed with tincture of gum guaiacum. The infusion is bitter and pungent; the slices taken out of the infusion became brown when moistened with tincture of gum guaiacum, and afterwards changed to a blueish green, to which succeeded spots of fawn colour. Infused in distilled vinegar the liquid became bitter and warm, and the slices were changed to brown on adding the tincture of the gum. Starch is also obtainable from these bulbs. It contains the new alkali called veratrine, from its being found in white hellebore roots.

Dolichi Pubes.—Cowage being so irritating to the skin, and at the same time so light, that it cannot be prevented from affecting those that handle the pods on which it grows, the chemists seem to have been deterred from examining it. For medical use, in cases of round worms in the intestines, the pods are plunged in honey or treacle previous to the cowage being scraped off from them. It has been lately recommended as an external stimulant to keep those that have taken an over dose of opium awake; but the bystanders must expect to feel some of its teasing effects, in spite of every caution.

Euphorbiæ Gummi-resina.—Gum euphorbium is another teasing irritant. It has no smell, but its powder causes intolerable sneezing and inflammation of the nostrils. When chewed, it seems tasteless, but soon gives the sensation of the tongue, palate, and throat being pricked by a thousand needles: this burning flavour is extremely permanent. At a candle it takes fire, and burns with a brilliant, smoky flame, but very little drops down. Rubbed with water, it renders the liquor milky, but only one seventh part is dissolved; the solution is milder than the gum itself. Spirit of wine dissolves about a quarter; the tincture is straw colour, very acrid, and is rendered white by water. Ether takes up 60 per cent.; the ethereal tincture is opal-like; when evaporated on water it leaves a transparent rosin, and an opaque, adhesive, white mixture of rosin and wax; the water is also rendered milky. The rosin of euphorbium is acrid in the extreme, it is not soluble in alkalies, but soluble in the sulphuric and nitric acids. Braconnot says, euphorbium contains 37 per cent. of rosin, 19 of wax, 20·5 of malate of lime, which was mistaken for gum, 2 of malate of potasse, 5 of water, and 13·5 of woody matter, 3 being lost in the analysis.

Guaiaci Gummi-resina.—Gum guaiacum has no smell, its taste is bitter, rather acrid, and when swallowed causes a burning sensation in the throat. In powdering, it emits a pleasant balsamic smell; the powder is at first gray, but becomes green by exposure to air: this change takes place very soon in the sunshine, and oxygen is absorbed by it. Water extracts from it about 9 per cent. of extractive matter; the infusion is greenish brown, and has a sweetish taste. Spirit of wine dissolves nearly the whole of this gum, leaving only 5 per cent. of insoluble matter. The tincture is deep brown; water causes a white precipitate or rosin to fall down; spirit of salt, an ash gray; sulphuric acid, a pale green; oxymuriatic acid, a fine pale blue; dilute nitric acid changes it after some time green, then blue, lastly brown, when a brown precipitate falls down: acetic acid and the alkalies do not affect this tincture. Ether dissolves only one tenth of gum guaiacum: the tincture has the same properties as the spiritous; when evaporated on water, it leaves a tough, transparent, pale brown pellicle, which turns green. Sulphuric acid dissolves gum guaiacum, the solution is a fine claret colour, and on adding water lets fall a lilac precipitate. Nitric acid dissolves it: much nitrous gas is emitted, and on distillation oxalic acid is formed; dilute nitric acid only changes it into a brown rosin. Spirit of salt dissolves a small portion; this solution is brown. By distillation it yielded 5·5 per cent. of acidulous water, 24·5 of thick brown oil, 30 of a thin fine oil, 30·5 of charcoal, and 9·5 of gas, chiefly carbonic acid gas and carburetted hydrogen.

Hellebori nigri Radix.—The fibres of hellebore roots have an unpleasant smell, and in powdering produce violent sneezing; their taste is acrid, nauseous, bitter, benumbing the tongue, as if it had been burned by a hot liquid. The infusion is red, bitter, and turns brown with green vitriol. The distilled water is acrid, as is also the watery extract, of which they yield about one third of their weight. Spirit of wine extracts the acrid part or rosin of these fibres.

Jalappæ Radix.—Jalap has a heavy but sweetish smell; its taste is sweet, but slightly acrid, and lasting. In powdering it irritates the nostrils and fauces. The extract by water is very mild. Spirit of wine dissolves the resinous part, which may be precipitated by adding water: this rosin, of which jalap yields 10 per cent. is pungent. Ether dissolves 30 per cent. of jalap, and leaves on evaporation over water, a tasteless transparent rosin, and some extractive matter. The College extract is made by first extracting the rosin by spirit of wine, which is afterwards distilled off until the tincture grows thick; then boiling the sediment in water; to the strained decoction, when evaporated until it begins to thicken, the concentrated tincture is added and the evaporation continued to dryness.

Lyttæ.—Spanish flies had their Latin pharmaceutical name of cantharides changed to lyttæ, which was the entomological name of the insect at the time of the publication of the Pharmacopœia, but which has since changed to meloe, and lately restored to cantharis, by Latreille; thus affording another instance of the impropriety of changing the pharmaceutic names for those of the naturalists, which are now constantly varying, in consequence of their names being given to the articles from the place of the latter in the systems in vogue, instead of the usage of the world, even although they are the subject of extensive commerce. Spanish flies have a disagreeable smell; their taste is acrid; applied to the skin they produce blisters, and a serous effusion. The infusion is acrid; exposed to the air it lets fall a yellow sediment, emits an urinous smell, and becomes acid; on adding spirit of wine, a black gluey matter was separated, which blistered the skin; the spirit of wine being evaporated, left a yellowish brown matter, which used by itself did not blister the skin. When fresh, they contain uric acid. If the flies are boiled in water, the decoction evaporated to the consistence of a syrop, spirit of wine added, and boiled, the tincture thus obtained evaporated to dryness, and the rosin digested in ether, the ethereal tincture, on being spontaneously evaporated, deposits crystalline plates, fouled with a yellow matter which may be removed by spirit of wine. These crystalline plates are the cantharidine of T. Thomson. They are insoluble in water or cold spirit of wine; boiling spirit dissolves them, but they separate as it cools; ether acts very slightly on them, but the oils very powerfully. The solution in oil is as strongly vesicatory as the cantharidine itself.

Mezerei Cortex.—The College have ordered the bark of the spurge olive, daphne mezereum, but that of the spurge laurel, daphne laureola, is the article usually found in the market: the substitution is of no consequence, as both have the same qualities; it is only another instance of the error of attempting to identify vegetable drugs by their botanical names instead of their sensible qualities, which, in respect to pharmaceutic students, is really explaining a thing supposed to be unknown, by one still less likely to be known; and in the case of foreign drugs, as the various kinds of cinchona, by positively inaccessible characters. Spurge olive bark when dry, has little smell, but on chewing it burns the mouth and fauces, and the heat continues for many hours. Moistened with vinegar and bound on the skin it opens an issue. The decoction is acrid and hot. Spirit of wine extracts an acrid tincture, which being concentrated, mixed with water to separate the rosin, and the filtered liquor mixed with a solution of sugar of lead, a yellow precipitate fell down. This precipitate being diffused through water, and a current of sulphuretted hydrogen gas passed through the liquid, sulphuret of lead was precipitated; and the liquor being filtered, and then evaporated, yielded small, transparent, hard, grayish, very bitter crystals, of the new alkali daphnine: by some considered as a variety of the bitter principle of vegetables.

Pimentæ Baccæ.—Allspice has an agreeable spicy odour, resembling that of a mixture of cinnamon, cloves, and nutmegs, whence its English name; the taste is warm, pungent, and slightly styptic. The infusion is reddish, spicy both in smell and taste; it turns black immediately with green vitriol, and a precipitate falls down slowly; nitrate of quick silver causes a yellowish brown precipitate, sugar of lead a dirty green, nitrate of silver a deep reddish brown, sulphuric acid a pale rose colour, muriatic acid the same; nitric acid turns it yellow. The distilled water is fragrant and hot; the essential oil is brownish red, very strong smelling, and excessively hot to the taste; it sinks in water. The tincture possesses all the sensible qualities of the allspice itself. The watery extract is mild, but the rosin is aromatic. The ethereal tincture, evaporated on water, leaves a greenish yellow oil, a pungent, nauseous rosin, and some extractive matter.

Piperis longi Fructus.—Long pepper has an aromatic odour; the taste is hot and pungent. Its chemical properties are similar to those of the black pepper. Ether extracts one fourth of this fruit, and the ethereal tincture, evaporated on water, leaves a rosin which is not so hot as that of black pepper.

Piperis nigri Baccæ.—Black pepper has an aromatic smell, which affects the fauces; the taste is acrid, very hot and lasting: when chewed, it burns the mouth and fauces. The infusion is brown: it reddens vegetable blues. The decoction is far more acrid that the pepper itself, and its taste lasts longer; it is precipitated by infusion of galls, and the precipitate is taken up when the liquor is heated. The distilled oil is at first colourless, but becomes yellow: it is extremely hot, the taste does not last so long as that of pepper. The tincture is very hot, and on distillation leaves a green, resinous, oily matter, having the smell and taste of the pepper. If spirit of salt is added to the tincture, water will throw down a rosin, and the muriate of piperine will remain in the liquor; which may be decomposed by potasse. Piperine is scarcely soluble in water; its tincture is greenish yellow. Ether dissolves 30 per cent. and being left to evaporate on water, leaves a yellowish rosin, intensely hot to the taste, smelling like pepper.

Porri Radix.—Leeks have a strong smell; their taste is also strong, acrid, and rather sweetish; they have not been examined by chemists, and are scarcely ever used in medicine; although the juice has been employed in dropsy and humoral asthma.

Pulegium.—Pennyroyal has a strong, spiritous, and rather heavy smell; its taste is aromatic, hot, with a flavour of camphire. When chewed, it heats the tongue and fauces. The infusion is yellowish, strong scented, aromatic, with a rather spiritous taste; it turns black instantly with green vitriol. The distilled water is aromatic; the essential oil reddish yellow, bitterish, with the smell and taste of the herb. Spirit of wine distilled from it, acquires also this smell and taste.

Pyrethri Radix.—Pellitory of Spain has no smell; its taste is at first none, but when chewed it is very sharp, hot; and this sensation lasts for some time, occasioning a copious discharge of spittle. The infusion is yellowish red, clear; its taste is weak, scarcely acrid: with green vitriol it becomes opaline, and a precipitate falls. The tincture is acrid, as is also the ethereal tincture.

Ricini Semina.—Castor seeds have no smell; when chewed whole they taste at first like almonds, but leave a sense of burning in the throat; a single one caused a strong man to spend a whole day in alternate vomiting and purging: the blanched seed has not this effect, which is occasioned by the rosin in the skin of the seed. They yield about one fourth their weight of mild oil, either by being tied in a bag and boiled in water, or by being blanched and pressed. This oil is a drug in the College list, as already mentioned, p. 255. Whether the College means that ricini oleum shall signify in prescriptions foreign castor oil, and oleum ricini English drawn oil, or whether these names are to be considered as synonymous, the College has not explained. If they are to be considered synonymous, it is a pity that the materia medica and the preparations should have had two different systems of nomenclature applied to them.

Rutæ Folia.—Rue leaves have a strong, heavy, yet not disagreeable smell; their taste is bitter, nauseous acrid. The infusion is reddish like that of tea, bitter, turns brown with green vitriol. The distilled water smells like the herb, but is not acrid. The essential oil is red, pungent, has a weaker smell than rue, but tastes strongly of it; by standing, it deposits a brown rosin. The extract is bitter, and acrid. The tincture is also acrid.

Sabinæ Folia.—Savine leaves have a strong, heavy, disagreeable smell; their taste is bitter, hot, and acrid. The distilled oil is colourless, with the smell and taste of the plant. The tincture is bitter and acrid; on being distilled, there are obtained a yellow oily mass, which is rather bitter and very biting, and also a black tough rosin, less biting, and rather astringent.

Scammoneæ Gummi-resina.—Aleppo scammony has a heavy, disagreeable, somewhat fetid smell; its taste is nauseous, rather vitriolic. When chewed, it melts with difficulty, but softens and sticks to the teeth; it is often sandy. Rubbed with a moist finger it grows white. Water dissolves about one fourth of it; the solution is greenish gray, lightly mucilaginous and opaque. It is not affected by spirit of wine, sugar of lead, liquor plumbi acetatis, green vitriol, nitric or muriatic acid, or ammonia: sulphuric acid produces the smell of vinegar, and potasse water a yellowish precipitate which is dissolved on the addition of an acid. Spirit of wine, when pure, dissolves about two thirds of scammony, but proof spirit dissolves it entirely. Ether dissolves about one fifth, on evaporation a brownish semitransparent rosin is left.

Scillæ Radix.—Sea onions, or squills, as they are more commonly called, have scarcely any smell; the taste is bitter, acrid, nauseous, and lasting a long time. They are difficult to dry, as they grow soft and mouldy; the dried shreds preserve their bitterness, but lose the acridness. The expressed juice reddens blue vegetable colours: nitrate of quick silver, and sugar of lead, throw down from it white curds; isinglass jelly, lime water, and pearl ash, also produce a precipitate, infusion of galls a pale brown, green vitriol a green, and when the juice is boiled down to one half, citrate of lime is deposited. The remaining juice being evaporated to dryness, digested in spirit of wine, the filtered tincture distilled to dryness, and the residuum dissolved in water, a solution of sugar of lead was added, which precipitated tannin; a current of sulphuretted hydrogen gas was then passed through the liquid to separate the lead by the sulphur of the gas combining therewith. The liquor being then filtered and evaporated left a white, transparent substance, considered by Vogel as a new vegetable principle, by the name of scillitine. It is intensely bitter, but mixed with a little sweetness from some sugar that he could not separate from it. He found the sea onion to contain 35 per cent. of this bitter principle, 24 of tannin, 6 of sugar, and 30 of woody fibre, along with citrate of lime and gum. The infusion and tincture are both acrid and bitter, as is also the infusion in vinegar. The ethereal tincture is pale green, and leaves on evaporation upon water, a very bitter rosin; the water becomes intensely bitter, and yields a precipitate with sugar of lead and nitrate of silver.

Senegæ Radix.—Rattlesnake root has a weak, not unpleasant smell; the taste is at first nauseous; when chewed it is warm, then rather acid, and produces a kind of tingling in the fauces, the central woody part being left. The infusion is pale yellow, with a weak smell, but a strong taste of the root; it is not altered by green vitriol. Spirit of wine extracts a tincture, which has the taste of this drug; the addition of water throws down an acrid rosin. The ethereal tincture, on evaporation, leaves a similar rosin.

Sinapis Semina.—Mustard seed has a weak smell; the taste is bitterish, warm, acrid, but not lasting; when chewed it bites the tongue. The flour is obtained by drying the seed until it yields a powder upon being bruised; which is then sifted to separate the brown hull. This flour is far more pungent than the powder of the whole seed. When taken, mixed with water, it draws tears from the eyes, and threatens suffocation; this sensation is instantly stopped by smelling to bread. The infusion of the seed is pale, opaline, with a strong smell, and a sweetish, acrid, warm taste; it is not changed by green vitriol. The distilled water is acrid, and the remaining seed mild, mucilaginous, and rather sweetish. The essential oil is limpid, heavier than water, excessively pungent and penetrating. The tincture is less pungent than the infusion. The flour mixed with vinegar is rendered still more pungent; and when rubbed with lime yields the smell of ammonia. Mustard seed by expression yields a mild oil that soon grows rank; it is also obtained from the hulls left in preparing the flour: the remaining cake is more pungent than the unpressed seeds or hulls.—From the great use made of flour of mustard as a sauce, its pungency is sometimes increased by adding Guinea pepper, and its price reduced by salt, turmeric, and the flour of white mustard seed, which is far inferior in pungency. The ground cake of the pressed hulls is used along with long pepper, for reducing ground pepper.

Staphisagriæ Semina.—Stavesacre seed have a weak disagreeable smell; the taste is bitter, and very acrid; when chewed, they burn the mouth and increase the flow of spittle. The infusion is red, strong scented, very bitter, not altered by green vitriol. The decoction being boiled with calcined magnesia, deposited a sediment, which being boiled with spirit of wine, the tincture filtered and evaporated to dryness, left a white powder, considered as an alkali, and called delphia or delphine. This is very bitter but scentless; it melts by heat, and on cooling becomes hard, brittle, and similar to rosin. Water scarcely dissolves any perceptible quantity of it, but acquires an acrid taste. Spirit of wine and ether dissolve it with ease. It combines with the acids, and the combinations are remarkable for their bitter acrid taste.

Toxicodendri Folia.—Poison-oak leaves, so called because the tree exhales at night an acrimonious vapour which inflames and blisters the skin of those who remain under it, although the juice of the plant does not. This juice is milky, but turns black. The leaves have no smell, their taste is mawkish and slightly acrid, they excite a heat and pricking in the limbs, with irregular twitchings. The infusion seems slightly acrid, it yields a precipitate with isinglass jelly, a black with green vitriol, and a brown with nitrate of silver.

Veratri Radix.—White hellebore root has a disagreeable smell; its taste is nauseous, very pungent and lasting; when chewed it burns the mouth: the powder excites violent sneezing. The infusion is reddish, with a disagreeable smell, and a sharp bitter taste appearing to corrode the fauces, lasting a long time. The decoction being long boiled, and sugar of lead added to it, yields a yellow precipitate; a current of sulphuretted hydrogen gas being then passed through the clear liquor, separates the lead by forming an insoluble sulphuret. The filtered liquor concentrated by evaporation being saturated with calcined magnesia, and the precipitate boiled in spirit of wine, yielded on distilling off the spirit an extremely bitter powder, unitable with acids, and hence considered as an alkali by the name of veratrine, or sebadilline, it having been also found in the Indian caustic barley called in Spanish çevadilla: this alkali is also separable from the roots of meadow saffron, and is probably the active ingredient in the nostrum called eau d'Husson. Veratrine melts in a gentle heat, and becomes an amber-colour transparent mass. Boiling water dissolves only the thousandth part of its weight; the solution is acrid. It is very soluble in spirit of wine, and rather less so in ether. Like delphine and some other new alkalies, as they are called, it appears to belong rather to the rosins than to the alkaline salts; and to be considered as an alkali, chiefly because the discovery of a new alkali is a better feather in a man's cap than that of a new rosin.

Zinziberis Radix.—Ginger has a spicy smell; its taste is warm, pungent, and spicy: when chewed it breaks down, burns the tongue and fauces, and this sensation is very lasting, causing an increased flow of spittle. The infusion is pale yellow, rather turbid, smelling like ginger, and warm; its colour is not changed by green vitriol, but it yields a precipitate. The distilled oil is red, limpid, with the taste and smell of the root. Rheede says it swims on water; but that sold in the shops sinks in water, has a smell of turpentine, and is rather bitter. Rubbed with water, this root yields by settling a large proportion of starch mixed with some acrid rosin, which may be separated by digestion with spirit of wine, which dissolves the rosin, and leaves the starch pure.

Cubebæ.—Tailed pepper, so called from the footstalks being left on this kind of pepper, has a strong aromatic smell; the taste is spicy, pungent, and hot: when chewed, it heats the mouth and increases the flow of spittle; in powdering it irritates the nostrils. The infusion is reddish, rather cloudy, the smell strong, the taste that of the drug; it is not changed in colour by green vitriol, but a precipitate falls. The distilled oil, of which they yield but a small proportion, is reddish yellow, smelling of the pepper, very hot, thicker than most essential oils, and inclining in consistence to oil of almonds. The rosin obtained by spirit of wine is acrid.

Secale cornutum.—Spurred rye, called by the French country people ergot, from the long bent slender form of the grains of rye thus affected, and the consequent similarity to the ergots or spurs of a game cock. These blackened and diseased grains have not been chemically examined; the flour is acrid, and has been alleged to have caused a gangrene of the extremities in those who have eaten bread made from rye part of which was thus affected; but this is denied by others. The country midwives in France have long used it as a stimulant to promote the progress of labour, and it has lately been attempted to be introduced into regular practice in this country; but the difficulty of obtaining it impeded its becoming fashionable, before it had palled upon the ear.

The slighter acrids enumerated in the Pharmacopœia are cambogia, cardaminis flores, contrayervæ radix, croci stigmata, digitalis folia, fœniculi semina, ipecacuanhæ radix, linum catharticum, rhamni baccæ, spigeliæ radix, and vinum.

Cambogia.—Gambooge has no smell, and scarcely any taste; when chewed it first breaks, then sticks to the teeth, is dissolved, and tinges the spittle with a golden yellow, giving the sensation of drying to the mouth. In a candle it takes fire, and burns with a bright, crackling, sparkling flame, with smoke; at first it softens, then part melts and drops, the remainder grows black, swells and is changed into a shining friable charcoal, scarcely dirtying the fingers. In a ladle it slowly softens by heat, but does not smoke, nor melt, but by degrees grows black and is changed into a soft, toughish black mass, which being pulled out leaves some black shining vestiges in the ladle. Gambooge moistened with water produces a fine yellow; which colour is brought out quicker by the spittle. It dissolves by rubbing or shaking in plain water, the solution is milky and pale yellow; in spittle the solution is milky, thick like cream, and adheres to the glass; in spirit of wine, the solution is golden yellow. All these solutions let fall a sediment, but that in spittle very little. Oil of tartar added to these solutions turns them red, and causes a precipitation; the precipitate from water is reddish yellow, the remaining liquor rather clear; from spirit of wine red, the remaining liquor clear. Water takes up about two thirds, the solution is not precitated by spirit of wine but rendered transparent; green vitriol turns it pale olive brown, but no precipitation takes place. Spirit of wine dissolves 90 per cent., and after settling it becomes transparent and deep yellow; water renders this tincture cloudy and bright yellow, but it is long before any thing falls down. Ether dissolves 60 per cent., the ethereal tincture is deep gold yellow and transparent; when evaporated on water, it leaves an orange coloured rosin, which does not colour water. In oil of tartar gambooge is softened, rendered tough, and then dissolved; the solution is blood red somewhat yellowish, scarcely any thing settles from it. If more gambooge is added than the oil of tartar will dissolve, it is coloured red and appears like clotted blood. Spirit of sal ammoniac dissolves gambooge; the solution is orange, and is not precipitated by water, but acids throw down a yellow precipitate, which is taken up again by adding the acid to excess. Gambooge undergoes no alteration in sweet oil, but it colours oil of turpentine red, although it is not perceptibly soluble in the oil. Gambooge was separated by Braconnot into one part of cerasine or tragacanthine, and four of a reddish brittle rosin, which dissolved in spirit of wine and the alkalies. Nitric acid converted it into a yellow bitter matter, and oxymuriatic gas deprived it of its dark colour, whilst it neutralized the muriatic acid that proceeded from the oxymuriatic.

Cardaminis Flores.—Cuckow flowers, so called because they come out in the spring, when the cuckow is first heard, or ladies' smocks, as they are also called, because these white flowers appear on the surface of the splashes of water where they grow like linen laid out to bleach, have no smell; their taste is slightly bitter and pungent; the decoction is bitter, but they have not been chemically examined.

Contrayervæ Radix.—Lisbon contrayerva, or at least the root of dorstenia contrayerva, is ordered by the College; but as Houston has shown that the roots of some other species of dorstenia are collected and sold under this name, the apothecary should have had the characters given by which he might ascertain the proper sort. Spanish contrayerva, said to be the root of psoralia pentaphylla, is that usually employed: a substitution the more remarkable, because the latter, which is distinguishable by its brown hue, is the dearest. Contrayerva has a heavy, not unpleasant smell, the taste is rather bitter; when chewed it heats the mouth, and leaves a lasting impression on the tongue; in powdering it affects the nostrils. The infusion is brown, having the taste of the root, it is not altered by green vitriol; the decoction is very mucilaginous. Spirit of wine extracts a tincture which reddens vegetable blues, is not altered by green vitriol, but is precipitated by water; and on the spirit being distilled off, leaves a rather acrid rosin with the taste of the root.

Croci Stigmata.—Saffron, or the stigmata of the purple autumnal crocus, carefully dried, has a pleasant, penetrating smell; its taste is spicy and rather bitter: when chewed it is tough, but grows soft and colours the spittle of a yellowish red: its toughness will scarcely allow it to be powdered. The infusion is yellowish red, with the smell and taste of the drug, by keeping it loses its colour; it is not altered by spirit of wine. Sulphuric acid turns it purple, and on this mixture being diluted with water, a black precipitate falls; oxymuriatic acid produces a yellow precipitate, the liquid remaining pale lemon colour. The essential oil is very fragrant and pungent, but very little can be obtained, a scruple from 4 oz. The watery extract is therefore chiefly extractive matter, and has been called polychrotte; it yields about 63 per cent. The tincture is deeper coloured than the infusion, it is not rendered milky by the addition of water, but preserves its transparency. The ethereal tincture is coloured, and when evaporated on water a rosin is left, and the water is coloured by the remaining extractive matter, which forms a brown flaky precipitate with muriate of tin. Saffron is chiefly used in pharmacy as a colouring ingredient; that which is in shreds, called hay saffron, is less liable to be adulterated than the cake saffron, which may indeed, like powdered bark, be had at any required price, however small.

Digitalis Folia.—Fox-glove leaves have no smell when green, but acquire a slight narcotic smell by drying: the taste is bitter and nauseous. The infusion is pale olive green, with the smell and taste of the plant; green vitriol renders it darker, nitrate of silver produces a dark violet precipitate, and corrosive sublimate a yellowish; galls, or emetic tartar, do not produce any. The tincture is rendered milky by water. Ether extracts about 30 per cent.; the ethereal tincture on being evaporated over water left a dark green oily rosin, and the water retained extractive matter. The watery extract yielded volatile sal ammoniac by distillation. The effects of digitalis in a small dose are powerful, and its accumulation in the system must be carefully guarded against; the decoction has been given largely, but still requires caution.

Fœniculi Semina.—Sweet fennel seed, the finocchio of the Italian cooks, has a fragrant smell, and a spicy, sweetish, warm, grateful taste. The infusion is aromatic, and not altered by green vitriol. The distilled water is milky, and aromatic; the essential oil, 30 oz. of which was yielded by 75 lb. of the seed, is colourless, with the smell and taste of the seed; it congeals and becomes like butter at 20° Fahr. The expressed oil is mild.

Ipecacuanhæ Radix.—Ipecacuanha, as ordered by the College, is to be the root of callicocca ipecacuanha, besides which the roots of other plants are sold under the name of ipecacuanha: the brown, said to be the root of psycotria emetica, being esteemed the best, the gray or College ipecacuanha, and the white, which is said to be the root of viola emetica. Ipecacuanha has a rather heavy and slightly disagreeable smell; the taste is bitter; when chewed, rather acrid and very nauseous: in powdering it induces sneezing and affects the lungs. The infusion is slightly bitter, and rather pungent; it is turned brown by green vitriol. The decoction is reddish, slightly mucilaginous, very bitter, and turned black instantly by green vitriol. The extract by water is mild, slightly emetic; the rosin, extracted by spirit of wine, of which it yields about one fifth, is pungent, and emetic. The ethereal tincture on evaporation yielded a fat, oily, scented substance. The remainder left in making the ethereal tincture being digested in spirit of wine, flakes of wax fell down as the spirit cooled, more was separated by adding water. The tincture was then evaporated to dryness, the dried mass was reddish, very deliquescent, and powerfully emetic; on being digested in water, it left more wax undissolved. The water was then mixed with sugar of lead, and the precipitate washed, and diffused in water through which a current of sulphuretted hydrogen gas was passed to separate the lead; after which the liquor being filtered and evaporated, it left brownish red scales, of a substance named emetine, enumerated as a vegetable principle. Emetine has little or no smell, with a slightly bitter and acrid taste, but not nauseous. It runs to a liquid in a moist air, and is consequently very soluble in water. Spirit of wine also dissolves it, but not ether; the tincture is evidently alkaline. It is precipitated from all the liquids that contain it by sugar of lead; and is now said to be a combination of a new alkali, emeta, and some acid, with a colouring matter.

Brown ipecacuanha was found to contain in its cortical part 16 per cent. of this emetine; the internal woody part only 1·15. Gray ipecacuanha yielded 14 per cent. of emetine, and the white sort only 5. The greater part of all the roots is starch and woody fibre.

Emetine thus obtained is emetic and purgative, and has been proposed as superior to the powdered ipecacuanha, as if an expensive preparation was not as liable to be adulterated as a powdered drug.

Linum catharticum.—Purging flax has a faint smell, and a bitter taste. The infusion resembles that of tea, is yellowish, scentless, but very bitter, and grows black with green vitriol. The ethereal tincture is green, and when evaporated on water leaves a green bitter rosin, and the water contains an extractive matter.

Rhamni Baccæ.—Buck-thorn berries have a faint unpleasant smell; the taste is first nauseously sweet, like the smell, and afterwards styptic: when chewed they tinge the spittle purplish green. The seeds, which are four in each berry, are bitter, and when chewed colour the spittle yellow. The expressed juice is deep green, or if the berries are thoroughly ripe, purple. The infusion is purplish, clouded by a mucilage; it has the smell and taste of the berries, is turned red by spirit of vitriol, a darker red by nitric acid, dark violet by alum water, iron gray by oil of tartar, and black by green vitriol. The juice mixed with a little alum, or lime water, and some gum Arabic, produces by evaporation the water colour called sap green.

Spigeliæ Radix.—Indian pink root has the smell and taste of wood rotted by water. The infusion is deep red, rather thick, with a narcotic smell; it is not altered by green vitriol.

Vinum.—Under this name the College designate only the wine of Xeres, or Sherry as we now spell it. Wine in general is the fermented juice of the grape, and the numerous varieties of this liquor arise more from the manner in which it is made than from any variation in the juice, except that the grapes grown towards the northern limits of the zone in which they can be cultivated, from not fully ripening, yield a juice surcharged with tartar, and hence they make a harsher wine than those grown in warmer climates. The most common wine drank in England is Oporto, which is manufactured in the coarsest manner possible, the grapes, good and bad, being flung all together into a cistern, trod to bruise them, and then left to ferment till the skins and stalks that swim on the top begin to sink, when the liquor underneath is drawn off; and, for the purpose of enabling this worst of all wines to bear the voyage to England without the whole turning to vinegar, a third part of the coarsest Spanish brandy is added. To render it drinkable with any pleasure, it is, in consequence of this admixture, obliged to be kept until the fieriness of the brandy is abated and softened by the formation of a portion of vinegar. The manufacture of the French wines is the reverse of this slovenly mode: there the grapes are sorted, and any bad berries in a bunch separated; sometimes the whole are picked, and at all events the grapes are pressed by the screw or lever, and only the clear juice fermented. In consequence of this care the wine does not require the addition of brandy, to enable it to be kept or bear a voyage. Sherry is made from grapes which have had their stalks cut partly through, and been thus half dried on the vine, in order to render them more saccharine. Water is of course added in making the wine, which thus approaches to the raisin wine made in England from dried grapes: its acid is also neutralized by the addition of lime.

Wine on distillation yields an ardent spirit called brandy, which by redistillation affords spirit of wine properly so called. It is disputed whether this spirit of wine pre-exists in the wine, or is produced by distillation. Mr. Brande has found, that if the colouring matter of wine is separated by liquor plumbi acetatis, the addition of salt of tartar will, by that salt absorbing the water, separate the spirit equally well as by distillation, and that it will float pure on the surface of the oil of tartar: this ingenious method only shows that the alkaline carbonate will separate uncoloured wine into spirit and water as well as heat, but determines nothing respecting the composition of the original compound. The very different medical effects of wine from a mixture of water and spirit of wine, or even of spirit with the remainder of the wine from whence it has been distilled, are a strong argument that wine is not a simple mixture of what appears to be its ingredients, but a compound body sui generis, whose component parts may be separated, and united into two or more bodies, the mixture of which will not reproduce the original substance.

Both Neuman and Mr. Brande have given tables of the quantity of spirit of wine that may be distilled from different wines; and the latter has extended his researches to malt liquors. The results are very different; and as Mr. Brande's quantities are in every case that admits of comparison far superior, while the accuracy of Neuman is unimpeachable, it seems to indicate that the wine merchants, at least of England, are obliged to brandy all their wines to comply with the palates of their customers, which have been blunted by the common use of Oporto wine, since that wine has of late years come into fashion, partly through the recommendation of Dr. Johnson, who considered the finer French wines to be merely drink for boys, Oporto wine for men, and brandy itself for heroes. Neuman says, that 36 oz. of sherry yielded 3 oz. of highly rectified spirit of wine, 6 oz. of thick, oily, unctuous resinous matter, 2 oz. 2 dr. of gummy tartareous matter, and 24 oz. and 6 dr. of water; this is equal to 8·4 per cent. of spirit by weight. According to Mr. Brande, the average content of spirit in the sherry now sold is no less than 19·17 per cent. by measure, or nearly double the quantity as found by Neuman. The difference is still greater in Oporto, for Neuman found only 1 oz. 6 dr. of spirit in 36 oz. or 4·9 per cent. while Mr. Brande found the average to be 22·18 per cent.

Sherry is ordered to be used to extract the medical virtues of aloes, ipecacuanha, opium, and white hellebore root; the latter wine having been newly added to the Pharmacopœia under the idea of its being similar to the nostrum called eau d'Husson. The vinum ferri, which was formerly made with Rhenish wine, is now ordered to be made with sherry, but if good wine of this kind be employed, the solution will not take place. Sherry is also ordered, diluted with two thirds of water, to make the liquor antimonii tartarizati, by dissolving a scruple of tartar emetic in 10 oz. measure of the mixed liquor: but the retailers substitute currant or raisin wine of their own making for sherry; a saving of expense, which in this case, if the College formula is in other respects adhered to, renders the medicine of no use, the extractive matter precipitating along with the antimony. Would it not be better to restore the old method of impregnating the wine with crocus metallorum, or to use diluted spirit of wine as the solvent of the emetic tartar? The best raisin wine is made by infusing about 6 lb. of fruit in each gallon of water; and currant wine by dissolving about 4 lb. of sugar in each gallon of currant juice, which is much improved by boiling the bruised fruit previous to its expression: brown sugar being used for red or black currants, and white sugar for white currants. The liquor is then fermented by the addition of a little powdered argol or crude tartar, which is a better ferment than yeast; and when sufficiently fermented, the cask is stopped for some weeks, to allow time for the wine to deposit its lees, and then it is bottled.

The acrid substances are very variable in their actions, some, as ipecacuanha, acting immediately on the stomach and inducing vomiting, while others, as jalap, taken internally, pass into the intestines and induce a purging more or less violent; others, as verdigris, cantharides, white hellebore root, act even on the skin, producing either serous blisters or ulcers. In general they may be said to be incisive, resolvent, attenuating, and opening; and hence useful in all obstructions from a viscid matter. Being highly stimulant, they promote the secretions, and hence are useful in all cold diseases, in dropsy, and in all eruptive diseases of the skin, as also in chlorosis. They are antiseptic, and proper remedies against worms, as they tend to clear the intestines from that slimy mucus which affords a lodgment to those animals, as well as by acting on them as direct poisons. The milder acrids are used externally as rubefacients. These bodies are certainly hurtful in wounds and ulcers, unless too luxuriant granulations are to be repressed and consumed, or a viscid pus to be removed. The use of them is also to be avoided in very young children, who cannot bear the violence of their action; as also in cancers not yet open, in all hæmorrhages and fluxes, in bilious fevers unless well tempered by diluents, in hectic fever, and in all wasting of flesh.

Magistral Forms.—It remains to say a few words upon the forms in which medicines are usually administered. These are now much simplified from those used by our ancestors. In one point however we have, in a zeal for simplicity, departed from convenience. The old prescribers and the compilers of Pharmacopœias endeavoured, by diluting the stronger medicines and concentrating or acuating the weaker, to bring them to such an equality of strength that the dose of the different forms should be similar amongst themselves; whereas at present the doses of each of the forms, the tinctures for example, are as various as possible.

These magistral or extemporaneous formulæ as they are called, consist in general of one principal medicament, usually named the basis, although in some cases two or more drugs, or preparations of similar powers, are joined together, in order to form a compound basis of a more efficacious nature than can be obtained by any single substance. To this basis, which is to answer the principal indication in the cure of the disease, there is sometimes added an adjuvant, which assists and promotes its operation, chiefly by rendering it more soluble; a corrector, or even several, to prevent any unpleasant effects that might arise from the other component parts of the formulæ, either by neutralizing or separating the noxious ingredient, or by guarding the system from its effects, and sometimes by diminishing the solubility of the basis; a director, which however is at present rarely added, their action being very obscure, yet it is well known that squill directs the action of salt petre to the urinary organs, and guaiacum directs it to the skin; lastly, a vehicle, whose use is to reduce the whole to a convenient, and if possible an agreeable form.

Medical Incompatibles.—In forming these extemporaneous compounds much caution is necessary, lest by joining several ingredients their medical actions should be impeded by one another, or a new chemical compound formed, whose action may be totally different from that which is intended. The chemical action of bodies upon one another, when placed in contact in the human stomach, is so different in many cases from what takes place when they are joined together in the vessels of the chemical laboratory, that it is never safe to draw any inference in reference to the former from the phenomena they exhibit in the latter case, as to what may or may not be medically compatible with each other. The human stomach has also a power of resolving some compound substances, apparently inert, as leather, which will not easily yield to the means possessed by the chemist; and a capacity of separating them into simpler combinations that have a more marked action on the system. In some cases, even the apparent medical incompatibility of two opposite qualities in the same medicine does not hinder it from being of great use, in consequence of that apparent inconsistency itself, as is shown in the union of a cathartic and astringent quality in rhubarb. And these seem to be the reasons why the practice of the methodists, or rational school of medicine, which calls in the assistance of mechanical and chemical theory, has always been less successful than that of the empirics, who rely upon strict medical experience only, and pay no regard to any analogies derived from other sciences.

Chemical Incompatibles.—Even in the strongest apparent incompatibility of substances, speaking chemically, as in the union of acids with alkalies, an union which should, on theoretical grounds, form a compound whose medical qualities were very different from that of either of its component parts, yet this is not always the case. The cathartic power of magnesia is not checked but increased by union with astringent sulphuric acid, as is shown in the sulphate of magnesia, Epsom salt. So the same astringent acid forms a cathartic salt with soda, whose own action by analogy with salt of tartar should be cathartic itself, although not used as such. The addition of magnesia, of itself an alkaline earth, is nevertheless useful in augmenting the medical action of the vinegar of meadow saffron. From these examples it appears how little assistance can be derived from chemical theory in respect to the forming a compound medicine, of any determinate effect, from ingredients whose qualities in their separate state are known; and that real medical experience alone must be resorted to for the purpose of ascertaining its effects upon the human body. Hence it will be always proper, in exhibiting a new and untried extemporaneous formula, to proceed with caution, and not to place the least reliance upon chemical analogies.

Pharmaceutical Incompatibles.—In a pharmaceutical view, that is to say, in respect to the elegant appearance and pleasantness of a compound medicine, every thing that renders a liquid medicine thick, of a green or dirty hue, of a bitter or metallic taste; or any watery liquid greasy, or clinging to the mouth, may be considered as incompatible in that view of the subject. The case is the same when a sediment is produced by the mutual action of the several ingredients; and in like manner, substances that liquefy when rubbed together, are pharmaceutically incompatible when the intention is to form a solid compound. The incompatibility of the different ingredients in this mere pharmaceutical view, may be deduced from the theory of chemistry, or the chemical history of the several ingredients, as already related. Here the dispensing practitioner has a great advantage over a prescriber, both in regard to his being continually versed in the admixture of drugs, and also in that he can, in most cases, correct his errors, even although he compounds an extemporaneous medicine in the presence of the patient, or his agent; while the prescribing practitioner, in case of ordering a medicine whose ingredients are pharmaceutically incompatible, is open to the animadversions of the dispenser, who may not be disposed to rest silent on the occasion, especially if he be a practitioner himself.

It must, however, by no means be inferred, that substances pharmaceutically incompatible, are to be rejected as useless in the cure of diseases, for they sometimes form very efficacious medicines. In the College Pharmacopœia are two excellent formulæ, which are examples of this, the liquor ferri alkalini, and the mistura ferri composita.

Solid Forms.—The principal solid forms used for the exhibition of medicines internally are powders, electaries, under which may be included the linctus and bolus; pills; and lozenges.

Powders.—Powders are employed when a solvent cannot be found that would preserve the medical virtue of the drug, which is therefore reduced to powder, and thus presented to the action of the stomach and intestines. If a too quick action of the stomach is apprehended, the powder should be coarse; asarabacca being emetic when finely powdered, but in coarse powder its action is suspended till it reaches the intestines, and thus it becomes purgative. Liquids may be reduced to this form by proper ingredients: as quick silver by chalk or sugar; and tough or soft substances, by hard bodies, as some of the gum rosins by sugar, burnt harts horn, sulphate of potasse, prepared oyster shells, cream of tartar, as is exemplified in the powders ordered by the College. Sand is often used to prevent the particles of gummy substances from running together in making tinctures, and should be used in making Friar's balsam, the tinctura benzoes composita of the College, which for want of this addition fills the vessel with an unremovable mass of gruffs. On the other hand, some dry substances, when ground together, become moist, generally from the water of crystallization, which is set free by the action of the substances upon one another: as in grinding either green or blue vitriol with sugar of lead, or volatile sal ammoniac with blue vitriol, for cuprum ammoniatum; and some of the gum rosins become moist on being ground with salt of tartar. On this account, the prescribing practitioner should be careful to ascertain the action of the substances he intends to order, upon one another, particularly if any of them are of a saline nature, lest his intention of exhibiting a powder be defeated. The dose of a powder cannot well exceed a dr.; a scr. is commonly enough. When disagreeable to the taste, they may be enveloped in a wafer, moistened with some syrop to facilitate the swallowing of it. If substances of very different efficacy are mixed together, they should be ordered to be made up each dose by itself, particularly if the most powerful ingredient be heavier than the others. When a strong medicine is exhibited in this form, some innocent powder, as sugar, liquorice powder, magnesia, should be mixed with it. And when powders are frequently given to the same patient, care must be taken, by diluents and cathartics, to prevent the accumulation of them in the primæ viæ.

Electaries.—Electaries may be made of all kinds of substances by proper additions, but they are generally composed of powders brought to a proper consistence by syrop, honey, or by mucilage when they are to be taken immediately, as otherwise this ingredient would, by drying, lose its form. As syrop is apt to candy, Dr. Paris recommends treacle, clarified by boiling with an equal weight of water, and one eighth its weight of powdered charcoal, straining, and evaporating to a proper consistence. In general, powdered vegetables require three, or even four times their weight of syrop or honey. Heavy substances instead of syrop require the use of some conserve, as that of roses or hips. The dose of an electary is generally a dram, to be taken either by itself, or if nauseous, wrapped up in a wafer. If an electary is prescribed as a single dose, it is then called a bolus. When the electary is thin, it takes the name of a linctus, and this ought to be made very palatable, and if any powders are mixed with it, they must be ground extremely fine. This form is seldom used for oils; yet there are examples of it, as Locatelli's balsam.

Pills.—Pills are generally used when the remedies operate in small doses, and particularly for those that are bitter, acrid, gritty, or nauseous, or which are designed to act slowly and gradually, in some cases not till they have passed the small intestines. But this form will not do for those remedies that must be given largely, or which, from their liquidity, would require a considerable quantity of dry powder to reduce them to a proper consistence; or which, when exhibited in a solid form, would soon grow so hard as to pass unchanged through the body; or for those substances, that although solid before mixture, become too soft when rubbed together, as aloes and extract of gentian. Sometimes the addition of a resinous, glutinous, or viscid ingredient, as mastich, balsam of copaiba, or the like, will prevent the too quick solubility of the basis of the pill in the primæ viæ; or, on the other hand, some soluble substance, as mucilage, or soap, may be added, to have an opposite effect. Crumb of bread is a convenient vehicle to make up heavy mineral substances into pills, that are to be taken immediately, but it so soon grows hard that it requires the addition of a little treacle to keep it moist. The mechanical division of a pilular mass into any required number of pills, is performed by rolling it into a cylinder, as uniform as the eye will allow, of such length that a common rule, divided into inches and parts, being applied to it, will allow the dispenser to divide it into the required number of pills, or at least some sub-multiple of that number, which may be afterwards subdivided. In general, powdered vegetables require an equal weight of syrop, but only half their weight of water, or spirit of wine. The size of pills varies much in different places: the French make them as big as large peas; the Germans divide them very small, so that they will order 30 or 40 pills for a dose; in England a medium is observed, and the size of a small pea is the most usual magnitude, and two for a dose the usual number.

Lozenges.—Although lozenges, and similar hard confections, are frequently used for the exhibition of nostrums, they are seldom employed by the hospital-bred practitioner, partly on account of their not admitting a sufficient profit to the apothecary, by reason of the competition of the hard confectioners, who deal largely in the popular articles of this kind, and thus their proper price is well known. Some are made of powders, formed into a paste with such liquids as will make them cohere; which, if the solids are farinaceous, gummy, or slimy, may be any watery or vinous fluid; or if the solids are not of this nature, the requisite form may be given by gums, syrops, mucilages, or the like. Most lozenges are formed of sugar, mixed or impregnated with powders or essential oils. It requires an experienced hand to give them a neat form, which is another reason that ordinary dispensers do not like to deal in them.

Liquid Forms.—The usual liquid forms for the exhibition of internal remedies, may be reduced to the mixture, which will include the julep, emulsion, and draught; the infusion; and the decoction; to which may be added the elixir.

Mixtures.—Mixtures are liquid medicines composed of different fluids, or of a single fluid with soft substances, with or without powders mixed in such proportions as not to be disagreeably thick, or too mucilaginous. Hence each ounce of the liquid should seldom have mixed with it more than half a dr. of a powdered vegetable, 2 scr. of an electary or conserve, 15 gr. or a scr. of an extract: as to heavy powders, they can scarcely be exhibited in this form, as, if they possess considerable specific gravity, they would fall to the bottom before the patient could either pour out his dose, or at the utmost take it. In regard to the vehicle of a mixture, the principal object is to render the taste, smell, and general aspect, as pleasant as may be. When the remedy is very powerful, and of course the dose exhibited must be exactly determined, and when the mixture would be liable to be changed by the admission of atmospheric air into the vessel, each dose, which should not exceed an oz. and half, should be put up separately in draughts. The common phials used for this purpose are peculiarly awkward, as they seldom stand on their bottom, and never with any degree of safety; by which means the mixture is always brought in contact with the cork, and frequent accidents happen from the medicine being spilled. It were to be wished the English glass makers would imitate the ounce and ounce-and-half phials of the Dutch, which are as broad as they are long.—Juleps are clear, transparent mixtures, generally coloured red by cochineal, or blue by syrop of violets, which are of a pleasant taste and smell, being usually composed of an agreeable scented water, as that of roses, or orange flowers, sweetened with one or two dr. or even more, of syrop to each ounce; sometimes Hungary water, sweet-scented honey water, or any similar spirit is added. The foreign apothecaries sell large quantities of these in summer, as agreeable beverages for sober persons; but our English apothecaries are at present so earnestly engaged in attempting to procure the monopoly of the practice of physic, or to become salaried parochial officers like the clergyman and vestry clerk, and thus to depend upon the contents of their purse, or their intrigues, rather than their professional qualifications; that they despise every branch of trade, where the competition of others hinders them from getting a larger profit than other tradesmen.—Emulsions are artificial milks, formerly made of a variety of seeds, but now only of blanched almonds, ground with water and sugar. In the true emulsion, which is used as a diluent, antiacrid, and nutritive drink, to be taken at pleasure, whatever spoils the colour, consistence, and taste of the medicine, such as acids and coloured syrops, must be carefully avoided: but in some cases, almonds and yelk of eggs are used to form an emulsive mixture, and render resinous and oily substances miscible with water. As the true emulsion soon grows sour, no more must be made at once than is sufficient for a day's consumption.

Infusions.—Infusions are liquids impregnated with such parts of any vegetable or animal substance as they can dissolve by maceration, without boiling. In these the proportion of the water must vary according to the substance to be infused; but in extemporaneous prescriptions it is generally eight times the weight of the drug to be infused, and there is seldom any advantage gained by lessening this proportion, because many vegetables absorb three or four times their weight of water; and again, the solvent will often not take up more of the drug even if more were added, as we find in senna. In alterative infusions or teas, the proportion of water is generally much larger, yet seldom large enough, and this scanty use of the least valuable ingredient is one principal cause of the supposed inferiority of British herbs, as balm, or the like, to Chinese tea, which would be as disagreeable if made as strong. Infusions are only properly made of those plants whose virtue resides in an essential oil, or other volatile ingredient, which would be dissipated by heat; and it must be observed, whether the infusion does not differ according to the time the water remains on the substance infused, the degree of heat employed, or the exclusion of atmospheric air. In general, the ingredient that gives its peculiar smell to the drug is first taken up, then the colouring, astringent, and gummy parts; and in infusing senna, the admission of air speedily oxidizes the extractive matter, a yellow sediment falls, and the infusion gripes without purging.

Decoctions.—The solutions of some of the principles of vegetables and animals, obtained by boiling them in water, are called decoctions; of course substances containing active, volatile principles, or whose virtue depends upon extractive matter, or some other principle which is rendered insoluble, or inert, by the action of the air in long boiling, are improper for this purpose. In some cases, the decoction is clarified by white of egg being diffused through it, and it is then brought again to the boiling point to coagulate the white, which involving the particles floating in the decoction, enables them to be separated by the filter; but in most cases it is preferable merely to strain the decoction through only a coarse filter, and let these suspended particles pass, since the activity of a decoction sometimes depends upon them. Like infusions, this form will seldom keep, and requires to have fresh made every day.—Clysters are generally made by boiling some mucilaginous herbs in water, along with cathartics, or narcotic drugs, or nutritive substances; of which a double dose by the mouth is usually put into each clyster, although some think this is an erroneous practice. They should be injected blood warm, and in quantity 8, 10, or 12 oz. meas. for a grown-up person, 6 or 7 oz. for a youth, 3 or 4 oz. for a child, and scarcely 2 oz. for a young infant. Some prefer administering them with the patient resting on the right side, others while on the left.

Elixirs.—These, which are also called drops, from their being generally ordered to be given in that mode, were the boast of the chemists at the first introduction of their art into medicine. They opposed these concentrated medicines to the emulsions, juleps, and mixtures, with which the apothecaries loaded the tables and shelves of a sick man's room. It is no wonder then that the apothecaries looked upon them with an inimical eye. Even now they are as unwelcome to his sight as the ghosts of their inventors would be. The physicians who venture to prescribe them, are marked as enemies, and by no means entitled to their good word; hence they can be ordered only by those who are perfectly independent in purse and mind, or who rely on other than professional patronage. These elixirs are mostly of an oily or spiritous nature, but vary greatly.

Dressings.—As to the forms which are used for applications to the external surface of the body, as poultices, liniments, salves divided into unguenta or cerata, and plaisters: the first is generally left to the family of the patient, they ought to be so thick as not to spread farther than is designed, and yet so soft as not to irritate the part; oil is usually added to farinaceous poultices to prevent their growing hard. As to the oily forms, they are scarcely ever ordered as magistrals; the formulæ in the Pharmacopœia are thought to be in general fully sufficient for every indication, the cure of wounds and ulcers being now often undertaken with internal medicines only, and their surface merely kept moist with water or wet linen.

ADDITIONS.

To the aromatic bitters in p. 215, is to be added the calumbæ radix or calumbo root, which softens, and by chewing nearly dissolves in the mouth; it is bitter and slightly aromatic; its smell is weak and rather pleasant; the infusion has the taste and smell of the root; it is not altered by green vitriol, nitrate of silver, corrosive sublimate, or emetic tartar; but it is copiously precipitated by sugar of lead, liquor plumbi acetatis, or by an infusion of nut galls. The tincture is also bitter and aromatic. It affords an oil by repeated distillation with water, and the remaining decoction yielded malate and sulphate of lime. Planche obtained from this root one third its weight of starch, a yellow bitter rosin, and a large proportion of a substance which resembled animal matter.

The carui seeds, carui semina, enumerated among the pure aromatics, in p. 233, are spicy and pungent to the taste; they have an aromatic smell. By distillation with water, 6lb. unbruised yielded 4 oz. and an half of a pale yellow oil, having the smell of the seed, and the same taste, but much hotter. The distilled water is spicy. The extract by water has little or no spiciness. Spirit of wine carries over in distillation more of the taste of the seeds, but less of the scent, than is done by water. The spiritous extract is aromatic. The ground seeds are used by the Tartars as a stimulant food, either in the form of gruel or bread, to enable them to bear fatiguing journeys.

In looking over Beccher's Physica Subterranea for the motto prefixed to this work, I met with the following anecdote, in p. 467, which probably refers to platina. "Sub tali genere illa talci species complectitur, quæ in America in Guajana reperitur, quæ omnes probas auri sustinet, nisi quod amalgamari non velit; unde ab Hollandicis Directoribus, naturæ mineralium ignaris, totæ naves tali talco onustæ exoneratæ, et omnis illarum sarcina in mare dejecta est."

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THE END.

ERRATA.

Page 37, line 30, *for* 15 *read* 17.
120, — 14, *for* kindled *read* hindered.

N. B. *A further List of Errata will be found in p.* xxviii.

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