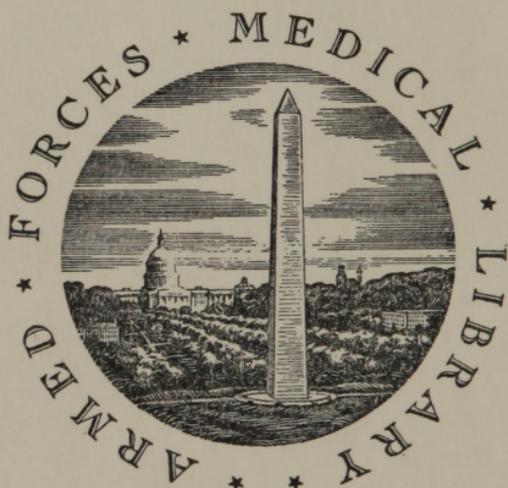


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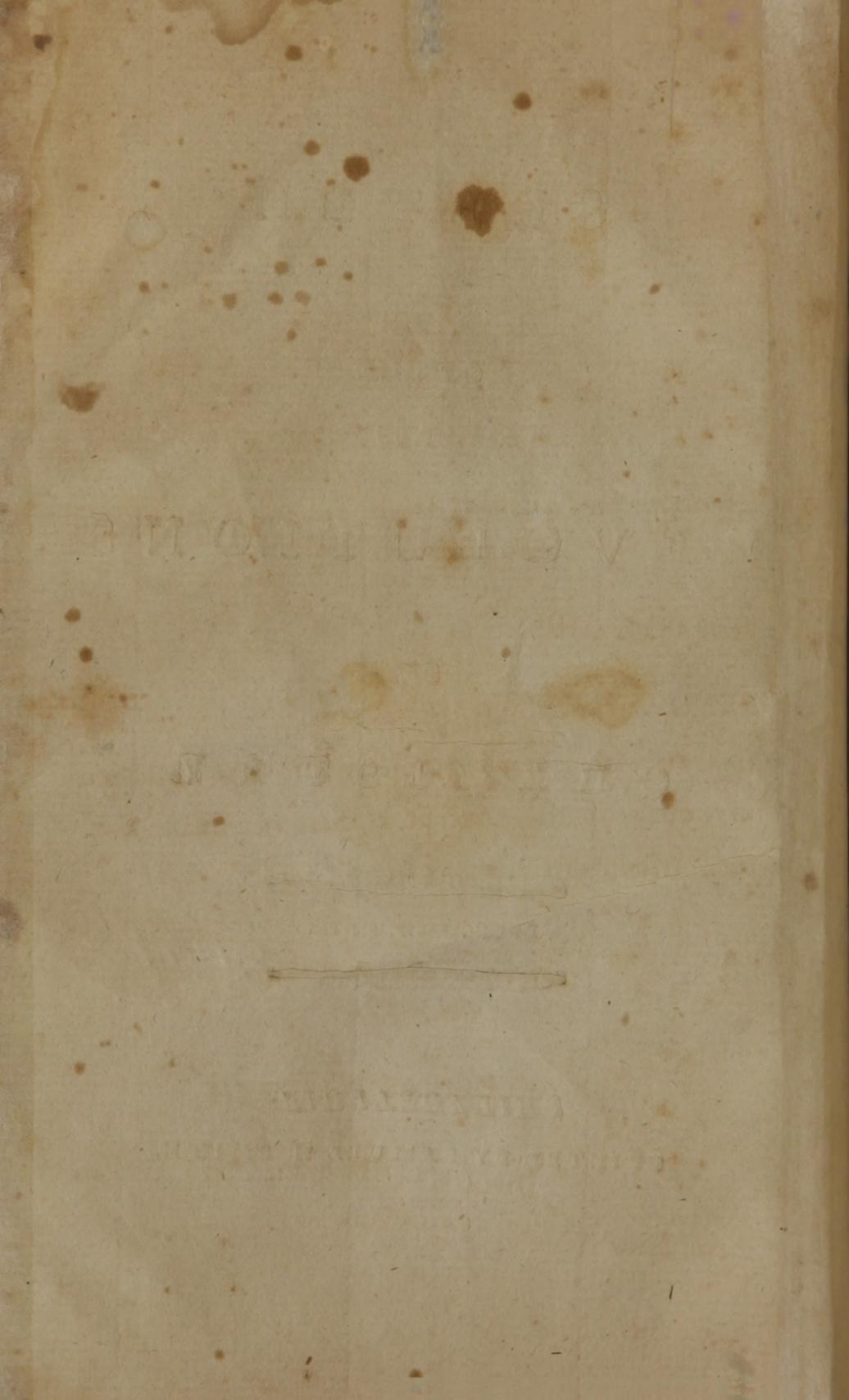
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TO ROBERT PATTERSON, A. M.

PROFESSOR OF MATHEMATICS IN THE UNIVERSITY OF
PENNSYLVANIA.

SIR,

I KNOW no person to whom my first essay can be
DEDICATED with so much propriety as to the instructor
of my early youth. Accept it then as a small, but
sincere, tribute of gratitude, from

Your friend
and pupil,

THOMAS P. SMITH.

TO THE HONORABLE MEMBERS OF THE HOUSE OF REPRESENTATIVES
IN SENATE CHAMBERS, WASHINGTON, D.C.
JANUARY 18, 1892

I have the honor to acknowledge the receipt of your letter of the 14th inst. in relation to the proposed amendment to the Constitution of the United States, which provides for the election of Senators by the people.

I am sorry to hear that you are unable to attend the meeting of the Senate on the 17th inst. I am sure that your presence would have been of great value to the Senate in this important matter.

I am, Sir, very respectfully,
Your obedient servant,
JAMES B. HAY

PHILADELPHIA LABORATORY,

APRIL 14th, 1798.

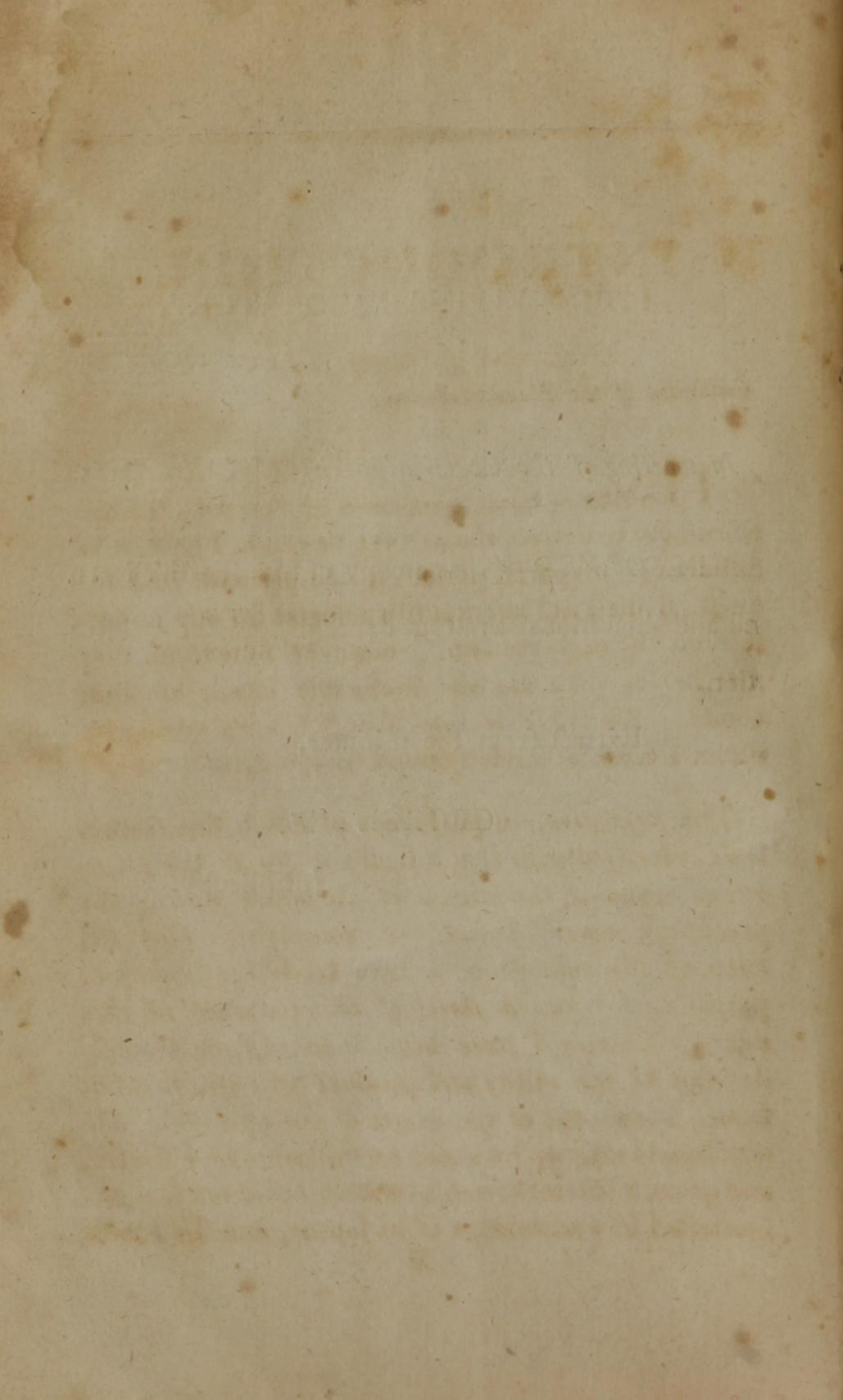
In meeting of the Chemical Society of Philadelphia,

RESOLVED—That a copy of Mr. Smith's learned and ingenious Oration be requested for publication.

Extract from the minutes,

GEORGE LEE,

Jun. Sec'ry.



INTRODUCTION.

Gentlemen of the Chemical Society,

HAVING been honoured by you with the appointment to deliver the ANNUAL ORATION, I have, with diffidence, prepared myself to comply with your request. I shall not attempt to apologize for any imperfections it may contain, however numerous they may be; as they are the inevitable effects of your choice. But there is one liberty I have taken, for which I consider myself bound to apologize.

The *Resolution*, in pursuance of which this oration is delivered, directs that it shall contain all the discoveries made in the science of chemistry during the preceding year. Instead of complying with the *letter* of this resolution, I have taken the liberty of preparing for you *a sketch of the revolutions in chemistry*. To this I have been induced from a consideration of the utility and pleasure that always result from a knowledge of the origin of our opinions. He who should take up his abode on the banks of a stream, and quench his thirst from its waters, could not feel uninterested in a knowledge of its source, and the course

it has run. Knowing over what substances its waters have passed, he is enabled in some measure to judge of their purity, and is put on his guard against any bad effects that may be produced by them. Thus, by knowing the origin of our opinions and the channels through which they have come to us, we can form a tolerable judgment of what particular prejudices they are most likely to be biassed by, and be thus put on our guard against receiving them without the strictest examination. Such were the reasons which induced me to write, and which I hope will induce you to pardon me for delivering before you, **A SKETCH OF THE REVOLUTIONS IN CHEMISTRY.**

S K E T C H, &c.

THE origin of CHEMISTRY, like the origin of every other science that early dawned upon mankind, lies buried beneath the dark fables of antiquity. The ascription of the discovery of truths, or the invention of arts, beneficial to mankind, to supernatural beings, was so general during those dark ages of ignorance and superstition, that we are not to wonder that the science of chemistry was supposed to have had a divine origin.

If music, poetry, and painting; if the arts of making wine, raising grain, healing the sick, had their tutelary deities who were supposed to have taught them to man, if the Egyptian, when he beheld the Nile, without any apparent cause to him, who was ignorant of its source, periodically overflow its banks, fertilize his land, and then peaceably retire within its proper limits, supposed it to descend from heaven, should we not expect that chemistry, a science to which almost all others owe their birth, would have

been supposed to have been derived from the gods. Accordingly we find this to be the prevailing opinion of the ancients. But however interesting an investigation of these fables may be to such as imagine them allegorical accounts of the origin of chemistry, we must pass them over as the unmeaning offspring of IGNORANCE and SUPERSTITION.

Were we to endeavour to search out the true origin of chemistry, we should find ourselves bewildered to little or no purpose among the multifarious traditions of antiquity: like the traveller who should in vain attempt to ascertain the true source of a great river, formed by the union of a number of small streams, we should after much labour and disappointment give up the pursuit as one in which the effect produced would not repay us for the labour endured.

The Arabians appear to have been the first people who made any considerable progress in chemistry. For however great the extent of knowledge in this science the votaries of antiquity may ascribe to the Egyptians, we cannot consider them as having made any great progress in it. It is true they had carried some of the practical parts of it, such as, the working of metals, imitating precious stones, and painting on glass, to a considerable degree of perfection; yet they do not appear to have possessed any knowledge of its general principles. It was as yet confined to the forge of the *smith* and the work-shop of the *lapidary*; and they expected their processes to termi-

nate favourably only because their predecessors, who perhaps were taught by some happy accident, promised them success. Their priests, indeed, pretended to extensive knowledge in this as well as in every other science, but as they have left us no data by which we can judge of their knowledge, we are led to believe that in these pretensions, as well as in those to great sanctity, their object was merely to gain an ascendancy over weak minds. The simplest ideas represented by their hieroglyphick characters were converted by the eye of IGNORANCE, who venerates every thing she does not understand, into the most sublime truths. Hence arose the idea that these priests, who perhaps understood little more than how to delude a superstitious, ignorant people, were possessed of a knowledge of all the arcana of nature.

Nor need we be surpris'd that this was the case in those dark ages, when even in this enlightened century men are found weak enough to spend their time in the solution of ancient fables, in search of truths which are only to be discovered by contemplating the works of nature, and who have the effrontery to declare that in these puerilities they can easily discern that the ancients were possessed of a knowledge of almost all that the moderns have thought themselves the discoverers. So far, indeed, has this blind attachment to antiquity been carried that it need not excite your surpris'e, if some one of these *fabulous commentators*, more deeply learned than his fellow labourers, should by means of a smoking chalice found on the pillar of Trajan, transfer from LAVOISIER to an Egyptian priest

the honour of the pneumatic theory ; or, by the bowl of the sacrifice overflowing with blood, painted on a Mummy, deprive PRIESTLEY of the honour of the discovery of the oxigation of the blood.

To the Arabians, then, is to be ascribed the honour of being the first nation in which chemistry ceased to be nothing more than a knowledge of a few processes in the arts confined to the work-shops of illiterate mechanics. To this nation we are indebted for its application to medicine which was first effected in the tenth century by Rhazes a physician of the hospital of Bagdad. It now became an object worthy the attention of men of letters and genius. The phenomena of nature were scrutinized with an attentive eye, new processes were instituted for determining her laws, and bodies before supposed *simple*, were analyzed by means of newly discovered agents. Such was the situation of chemistry in Arabia, when by means, apparently little favourable to the dissemination of science, it was transplanted into the west of Europe.

Towards the close of the eleventh century all *Christendom* was roused to arms by the declamation of an obscure individual of the name of Peter, surnamed the Hermit. This man, who to the most barbarous ferocity added the most refined cunning, travelled over Europe preaching up a *croisade* to recover from the hands of the *infidels* the *holy-land*. As his hearers were plunged in the most barbarous ignorance, their passions were easily wrought upon, and this man who in the eighteenth century would be confined in a *mad-*

house, or treated with contempt, in the eleventh raised an army of 700,000 men to effect his absurd scheme. This army of which BIGOTRY and SUPERSTITION led the van, and MURDER and RAPINE closed the rear, was composed of men of every rank and profession. And this army, however unfit a medium it may appear for the transmission of science, was the means by which chemistry was first transplanted into Europe.

That men actuated by such motives as the croisaders were, who, with the symbols of peace in one hand, and a reeking sword in the other, marked their footsteps with the blood of women and children; who had left their peaceful habitations, their wives, their children and all the joys of domestic happiness, to enforce by the sword the truth of a religion whose basis is charity, and to wrest from the hands of *infidels*, in another quarter of the world, a barren tract of land almost unfit for the habitation of man, because it was the birth place of their religion; that these men should be the disseminators of science, is a paradox in the history of the human mind that at first view appears inexplicable. But the difficulty vanishes when we recollect, that, happily for the cause of science, the chemistry of the Arabians was deeply tinged with alchemical notions*. The croisaders who were blind to the charms of science, were far from being so to those of gold. As soon, therefore, as chance threw in their way pretenders to the art of converting the metals, their avarice was roused, and for the sake of the promised wealth

* See note A. at the end.

they *condescended* to study chemistry. After the defeat of this immense army, many, who had set off with a design of converting the *infidels* to *Christianity* by means of the sword, returned to endeavour to convert all the metals into gold by means of their newly acquired chemical agents.

Europe soon swarmed with people in search of the agent, by means of which the baser metals were to be converted into gold and silver, and to which they had given the name of the Philosopher's-stone. All classes of people were seized with the mania. The indigent man, who was intigated to study by the hopes of acquiring wealth, but who for want of money to commence his operations was unable to proceed, was sure to find a patron among the wealthy, who upon the condition of sharing in the discovery, advanced large sums of money for carrying on the operations. Processes of the most extensive and expensive nature were instituted in search of this chimerical substance, and the most important discoveries, though different from that most hoped for, were made. No expence of labour or time was spared, and immense fortunes were dissipated by men who would not have advanced the smallest sum for the discovery of any truth whatever from which they could not hope to derive some pecuniary advantage. Thus was avarice enlisted in the cause of science, and thus that worst passion of the human breast, which has ever, but at this single period, retarded the progress of science, now tended in the most astonishing manner to its promotion.

That branch of chemistry called mineralurgy, particularly flourished during these researches. The metals were the objects to which the attention of the alchemists was immediately directed. Hence considerable progress was made in the art of extracting them from their ores and working them.

From an idea entertained by some of the alchemists that the philosopher's-stone was to be the result of an intimate union of *sulphur* and *mercury*, this semi-metal became in a peculiar manner the object of their attention. The result was that the materia medica became enriched with many invaluable preparations of it.

This period gave birth to a number of men of the most respectable talents; at the head of these we must rank Roger Bacon, who flourished in the thirteenth century, and whose mind was deeply tinged with alchemical notions.

In the course of some chemical experiments, Bacon having mixed nitre, sulphur and charcoal together, in a mortar, they by accident took fire and produced a loud explosion, this first suggested to him the idea of making gun-powder, which, from a false idea he entertained of the terrible effects that would be produced by its being generally known, he concealed in his writings under the form of an anagram.

In the sixteenth century a new sect of alchemists appeared, who were in search of a medicine that should cure all diseases.

The Arabians in their treatises on alchemy, had employed that figurative language which is so universal in the East. The agents they used for bringing metals to *perfection* they called *medicines*, the *imperfect* metals *sick men*, and gold a *sound, lively, healthy, durable man*. When the Europeans procured translations of these works many of them understood all these figurative expressions in a literal sense, and when in the course of their reading they met with passages like the following from Geber, "*Gold thus prepared cures lepras, cures all diseases,*" and in which he only meant it would transmute all the other metals into gold, they understood it to be a medicine by which all the diseases to which the human frame is liable might be cured*. Such was the origin of a sect of alchemists to whose industry we are indebted for the most valuable accessions to the *materia medica*.

At the head of this sect of alchemists stood Paracelsus, a name familiar to every chemist. He was born near Zurick in Swisserland, in 1493. From his earliest youth he seems to have possessed all that wildness of imagination which so strongly characterizes his countrymen. The moment he conceived a thing possible, he formed a theory for the performance of it, and then proclaimed to the world he had effected it. As soon, therefore, as he conceived of the possibility of forming a *panacea*, he commenced his search after it, and emboldened by the success of some of his mercurial pre-

* Boerhaave.

parations he declared he possessed the power of closing forever the door of the tomb.

Having likewise formed an idea of a liquor that should dissolve every substance in nature, and to which he gave the name of the *alcahest*, he declared to the world he had discovered it, and published a book in which he gave an account of many of its operations. This book abounds with the wildest extravagances and most palpable contradictions. In several passages of it he tells us of his having dissolved various substances in the *alcahest*, in vessels hermetically sealed, in which operations although the substances were readily dissolved, the vessels appear to have remained undissolved by this universal solvent. Van Helmont has likewise written much on *the alcahest*, and has the effrontery to declare that he possessed for a considerable time a vial containing this wonderful liquor, but that it was given to him, and afterwards taken away from him.

In addition to the panacea and alcahest, Paracelsus, declared himself possessed of the philosopher's-stone. Thus he persuaded the greater part of his cotemporaries that he was possessed of what they conceived the two greatest blessings man can enjoy, the unlimited power of encreasing his wealth and prolonging his life. Against the truth of an opinion so generally entertained by his cotemporaries, we shall offer but one objection. Paracelsus at the latter end of his life wandered about Europe in poverty, and died at the age of 48, to the disgrace of his boasted *aurum potable*,

azophs, little demons, elixers, and immortal catholicons, after a few days sickness at a public inn at Saltzburg, although he had flattered himself that by the use of his *elixer proprietatis* he should live as long as Methufelah.

The failure of Paracelsus did not intimidate others from pursuing the chimera, among the number, Cassius, known by his precipitate of gold ; Libavius, whose name is affixed to a preparation of tin ; Sir Kenelm Digby, who believed in the sympathetic action of medicaments ; Van Helmont famous for his medical opinions and chemical notions ; and Borrichius a Danish chemist, who first discovered the method of inflaming the oils by the nitric acid, are particularly to be noticed for their talents. To the labours of these men we are indebted for many valuable medicines. But in a peculiar manner they demand our gratitude for the intimate union they have produced between medicine and chemistry, the consequence of which has been that disease has been stripped of half its terrors.

Amid the dark gathering clouds of ignorance and superstition, that hung over all Europe during this century, one ray of light burst forth so pure and strong as to indicate a rapid dispersion of the worse than Egyptian darkness of the age. Francis Bacon, a name that must at once draw forth our pity and admiration, appeared at the latter end of the sixteenth century, and laid the foundation of natural philosophy on the true and immutable basis of reason. For some centuries past the world had been engaged not in discussing philosophical truths, but the opinions of philosophers.

The book of Nature, from whence alone true knowledge can be drawn, was entirely neglected, and the works of Aristotle and Plato were made use of to supply its place. Instead of endeavouring to discover her laws by observing their effects, they attempted to explain them by the *categories* of the Peripatetics or the *ideas* of the Platonists. But Bacon, perceiving that these *ignes fatui* only served to lead astray, chose for his guide the invariable light of reason. By this he soon perceived that a knowledge of the laws of Nature can only be acquired by observing her operations. He therefore advised mankind, instead of spending their time in interpreting the idle dreams of mystical philosophers, to forsake their air-built castles and by experiment erect their systems on the adamantine basis of truth. Not content, like the generality of reformers, with barely pointing out the road they ought to pursue, this able pioneer proceeded a considerable distance in it, and cleared the way to many of the greatest discoveries of his successors. But either from that love of unintelligible systems which is so common in ignorant men, or, from a dread of entering on a new road, the termination of which they could not perceive, it was some time before mankind could be drawn from the beaten track.

About this time Glauber, a German, rendered essential service to chemistry, by examining the residues of operations which had heretofore been thrown aside as useless and distinguished by the names of *caput mortuum*, or, *terra damnata*. By this he discovered the *sulphat of soda*, called after him Glauber's salts, the

Sulphat of ammoniac; and threw great light on the processes for preparing the mineral acids.

At the commencement of the seventeenth century the alchemical mania arrived at its acme. In Germany a society was formed under the name of the Rosicrucians, of which little more is known than that they pretended to be in possession of the secrets of transmutation, of the universal science and medicine, with the science of occult things. In France, England, Spain, and most of the other nations of Europe, the belief in alchemy was carried so far that decrees were issued by government forbidding it to be practised, lest the value of the current coin of the nation should be destroyed, or individuals practising it be rendered too powerful.

This triumph of error over reason, like every other triumph of the same nature, was, however, doomed to have an end. Father Kircher, a Jesuit, author of a great work entitled "*Mundus Subterraneus*," and Corringius, a learned physician, commenced an attack on it, which, by the aid of the philosophical chemists who made their appearance some years after, totally destroyed this chemical monster.

Chemistry had hitherto consisted of a multitude of facts, disseminated without any regard to arrangement over many loose dissertations on its various objects. "As yet," as Macquer observes, "there were many branches of chemistry in being, though the science itself was not yet in existence." To-

wards the middle of the seventeenth century James BARNET, physician to the king of Poland, first collected and arranged the principal known facts in a methodical manner, and added observations thereon. BOHNIUS, professor at LEIPZIG, likewise formed a methodical collection. But JOACHIM BECHER of SPIRES wrote a work entitled "*Physica Subterranea*," which from the precision with which the facts are related, and his observations on them, so far eclipsed the writings of BARNET and BOHNIUS that their works are now totally neglected, and their names almost forgotten. This work, in which there are a number of conjectures verified by late discoveries, had the honour of having for a commentator one of the brightest ornaments chemistry can boast—I mean the celebrated STAHL.

George Ernest STAHL was born at ONOLD in FRANCONIA, in 1660. From the earliest youth he appears to have been attached to the study of chemistry. But in a particular manner his mind was directed to ascertain the true principle of inflammability.

Until the time of BECHER, the most vague notions were entertained on this subject, the chemists supposing it to be a *sulphur* pervading all inflammable bodies. BECHER, perceiving that sulphur did not exist in many animal and vegetable substances, although inflammable, asserted that it was not the principle of inflammability, but that this principle resided in a substance common to sulphur as well as all other inflammable bodies; this substance he supposed to be of a *dry* na-

ture, and therefore called it an *earth*, and to distinguish it from all other earths, he called it PHLOGISTON. This doctrine was adopted by Stahl, who so far improved and extended it, that he is now generally considered as its founder.

The human mind delights in speculative reasoning. It can scarcely receive two connected facts without wishing to draw a general conclusion. It is this spirit of generalization, which has given birth to some of the most sublime as well as the wildest theories. Without it the mind of man would be ^{nothing} better than a wilderness of facts. Instead of ^{the} ~~the~~ ^{which} ~~which~~ ^{perfect} ~~perfect~~ ^{harmony} ~~harmony~~, it would be a ^{confusion} ~~confusion~~ ⁱⁿ ~~in~~ ^{which} ~~which~~ ^{although} ~~although ^{all} ~~all ^{the} ~~the ^{materials} ~~materials ^{for} ~~for ^{constructing} ~~constructing ^{the} ~~the~~ ^{temple} ~~temple ^{are} ~~are ^{contained} ~~contained, yet they are in so rude and deranged a state that the ^{temple} ~~temple~~ ^{is} ~~is~~ ^{neither} ~~neither ^{orderly} ~~orderly~~ ^{nor} ~~nor ^{elegant} ~~elegant~~. The affairs of mankind ^{are} ~~are~~ ^{reduced} ~~reduced~~ ^{to} ~~to~~ ^{the} ~~the~~ ^{wildest} ~~wildest~~ ^{theories} ~~theories~~; ^{and} ~~and~~ ^{whatever} ~~whatever~~ ^{may} ~~may~~ ^{be} ~~be~~, ^{serve} ~~serve~~ ^{the} ~~the~~ ^{purpose} ~~purpose~~ ^{of} ~~of~~ ^{giving} ~~giving~~ ^{some} ~~some~~ ^{sort} ~~sort~~ ^{of} ~~of~~ ^{arrangement} ~~arrangement~~ ^{to} ~~to~~ ^{all} ~~all~~ ^{the} ~~the~~ ^{down} ~~down~~ ^{fall} ~~fall~~, and any arrangement, however bad, is better than none. Nor need we be afraid that any false theory, however specious it may appear, will be permanent; for, **WHATEVER SYSTEM IS NOT FOUNDED IN TRUTH MUST FALL!**~~~~~~~~~~~~~~~~~~~~~~

As soon then as Becher's doctrine of phlogiston, as improved by Stahl, became generally known, it was adopted by the undissenting voice of the chemical world. It answered for the limited state of chemical knowledge, and the philosophers from his time until

within a few years past knew of no phænomena in combustion that they could not account for satisfactorily, *to themselves*, by this theory.

About this time lived Mayow, an English physician, famous for a number of *ingenious conjectures*. According to Dr. Haller, he supposed that *nitre* floating in the air was absorbed into the lungs and formed the *animal spirits*, the heat of the system, and imparted colour to the blood. Blumenbach says he was one of the first authors who wrote concerning the factitious airs especially that now called *dephlogisticated air* or *oxigene*, which was first discovered by Mayow. The work which contains his observations on this subject is entitled *Tractatus de respiratione, et de rachiti*, printed at Oxford in 1668. He was but 34 years of age when he died.

We have now arrived at the most brilliant era that has ever occurred in this science. Hitherto the progress of chemistry had been slow and uncertain. It depended on accidental discoveries made in search of chimerical objects. Its votaries were not led on so much by the love of truth as the love of life and wealth. But the theory of Becher and Stahl gave a new direction to the pursuits of chemists, and instead of the philosopher's stone, alcahest and panacea, their labours were now directed to the establishment of a theory of combustion.

Stahl, whose mind was entirely occupied with demonstrating his favourite theory, and observing all the

supposed modifications of phlogiston, seems to have overlooked the influence of air in all the phænomena which he attributes to his inflammable principle. The necessity of attending to this fluid in the operations of chemistry had already been demonstrated by Boyle and Hales. The difference between chemical events that happen in like circumstances in air and vacuo had been observed by the former, and the latter had procured from various substances different kinds of air. He thought air was the cause of solidity in bodies.

Dr. Priestley, in pursuing the experiments of Hales, discovered many elastic fluids which had heretofore been entirely overlooked by the chemists. Dr. Hales had obtained air from *minium* but he had not investigated its properties. On the first of August 1774, a day which will ever be conspicuous in the annals of science, Priestley obtained this air*, and found it much purer than atmospheric air. In the course of some experiments he instituted on this air, he found it to be the cause of the red colour acquired by the blood in passing through the lungs. This discovery has laid the foundation of a theory of animal heat that has thrown more light on the science of physiology than perhaps any other discovery ever made. †

* Called by him *dephlogisticated air*, from his supposing it to be air deprived of all phlogiston, and by the French chemists *oxigene*, from its being the principle of acidification.

† See note on combustion.

Mr. Lavoisier soon after proved that the weight acquired by heated bodies is owing to an absorption of oxygen.* To this discovery we are indebted for the French system of chemistry.

Before entering on this revolution, the greatest perhaps that has ever occurred in this or any other science, you will pardon me for occupying a few minutes of your time in paying the debt of gratitude we owe to him by whom it was effected.

Lavoisier was born at Paris, August 16th, 1743. From his earliest youth he manifested a genius of no common order. At the age of three and twenty he obtained from the Academy of Sciences a gold medal for a dissertation on the best mode of enlightening during the night the streets of a great city. Two years afterwards he was made a member of that justly celebrated society. As yet his mind was confined to no particular branch of science, but each in its turn was benefited by his attention. Until at length, about 1770, Lavoisier, struck with the importance of the discoveries which had recently been made by Priestley, Black,† Cavendish and Macbride, relative to elastic fluids, turned his attention to this inexhaustible source of discovery. He had now entered on a career which was to rank his name with those of Bacon, Newton and

* See note B.

† In 1755 Dr. Black discovered *fixed air* or the *carbonic acid* in *calcareous earth*. He affirmed that the dissipation of this air converts it into *lime*, and that by restoring it again to the *lime, calcareous earth* is regenerated.

Hartley. His time and fortune were devoted to furthering discoveries in chemistry, and his house became a great laboratory filled with every species of apparatus necessary in this science. Here he made welcome men of science to whatever nation they might belong, or to whatever opinions they might be attached. Twice a week he held assemblies at his house, to which was invited every person most eminent in geometrical or physical knowledge. Here all the new chemical opinions which appeared in Europe were discussed and tested by experiment. Before this assembly Lavoisier tried all his experiments, and listened with candour to the discussion of them. To this line of proceeding we are indebted for that accuracy of experimenting, which has been introduced, instead of the former incorrect mode. After his experiments and theories had passed this strict ordeal, and not before, he gave them to the world.

It is to these assemblies we are indebted for the new nomenclature, which the French chemists have introduced into this science. This nomenclature has tended considerably, by banishing much of the technical jargon of chemistry, to its promotion, and leaves nothing for us to wish, but that they who made so happy a commencement had extended it still farther. We may consider it as a happy omen of what we are to expect from an introduction of a philosophical language into the sciences.*

* See note C.

The effects of these labours of Lavoisier are to be found in forty memoirs, replete with the grandest ideas relative to the various phenomena of chemistry, published by him, from the year 1772 to 1793, in the transactions of the French academy. In 1784 he formed an idea of collecting into a single work all the discoveries he had given to the world at different periods. This work, which did not appear till 1789, exhibited the simplicity of his system in so forcible a point of view that it soon gained the almost universal suffrage of the chemical world.

Hitherto we have beheld Lavoisier only as the philosopher, rending the veil of nature, and drawing into view all her native charms. Let us now view him in the no less exalted station of private life. If as philosopher he raises our astonishment by the brilliancy of his discoveries and profundity of his reasonings; as a man he no less excites our admiration by his strict performance of all the duties of a friend, a relative, and a citizen. In short, Lavoisier was one of those truly exalted characters that prove the folly of the observation, made by *malicious ignorance*, that a love of science and a performance of the duties of life are incompatible.

Our picture has as yet displayed none but the most pleasing colouring—Would to heaven! I could, consistently with my duty put it out of my hands unfinished as it is. But there is one dark shade, which to complete it, must be laid in, and which will efface the pleasure arising from a contemplation of its beauties.

Lavoisier was strongly attached to the cause of SCIENCE and TRUTH, and consequently to that of LIBERTY. When the French revolution burst forth* on the astonished world, he, therefore, early appeared as its advocate. Until at length Robespierre, having descended from the elevated station of a Representative of the People, to the debased one of their Tyrant, perceiving that a love of science and truth naturally produced a love of liberty, determined on the destruction of all those who united these dangerous qualities. Lavoisier was one among the many marked out for destruction. No other excuse could be found for his execution, than that he had been a *farmer-general* under the old government: But this excuse weak as it was, was sufficient for the *tyrant*, who had the *power* and the *will* to destroy him. Let us draw a veil over the fatal catastrophe that has deprived the republic of science of its brightest ornament.* And while we mourn the loss of this benefactor of mankind, let us not lose sight of the pleasing hope that he and his *murderer* shall be remembered as they deserve. Yes! let us cherish the pleasing idea, that while the name of Robespierre shall be remembered with deserved detestation along with those of Nero and Caligula to excite indignation against tyranny and its supporters, that of Lavoisier shall ex-

* When the order for his execution was presented to Lavoisier he requested a few days to complete a course of experiments he had commenced, but this was refused and he was hurried off to the *scaffold*. What may we not have lost!

cite in the breast of every votary of science the warmest gratitude!

FROM the time of Stahl to that of Lavoisier the metals were supposed to be compound bodies, formed by the union of phlogiston with peculiar earthy bases. During their combustion or calcination they were supposed to part with this phlogiston to the surrounding bodies. Even the weight they acquired by this supposed loss of one of their constituent principles did not for a long time shake the belief of the followers of Stahl in their favourite theory. They all seemed eager to discover some opiate by which they might lull their reason to sleep. The celebrated Boyle affirmed that the increase of weight in calcined metals is owing to the combination of the matter of fire. Boerhaave attributed it to the surrounding bodies which deposite themselves upon the metal: While the generality of the followers of the doctrine of phlogiston supposed it to be the principle of *levity*. Such are the powerful effects produced by the union of a great name with any theory whatever; like the head of a monarch stamped upon base metal, it serves to give it currency for a time among the unobserving part of mankind.

At length Lavoisier proved that the increased weight of the calx is owing to the absorption of oxigene, and that it is in the exact proportion of the quantity of this gas absorbed. He now undertook to reverse the theo-

ry of Becher and Stahl. Instead of supposing that in combustion phlogiston is separated from the combustible body, he accounted for this phenomenon by the body absorbing oxigene from the atmosphere, which he discovered consisted nearly of twenty-eight parts of oxigene united to seventy-two of nitrogene.

The supporters of the doctrine of phlogiston, thinking it in vain to attempt any longer to uphold a system founded on the existence of so chimerical a substance as they had heretofore described, and perceiving that in many cases of the solution of metals in acids inflammable air is generated, declared this hydrogenous gas to be phlogiston in an uncombined state. No sooner had they given to this

—————“ airy nothing
“ A local habitation and a name,”

than they doomed it to destruction. While it retained its *Protean* powers of at one time being the principle of levity, and at another possessing gravity, it was impossible to grasp it firmly enough to destroy it; but it now became a fair object of discussion.

The French chemists were for some time at a loss to account for this disengagement of hydrogene. At length Mr. Cavendish discovered that water is a compound body, formed by the union of the basis of hydrogene and oxigene. The source from whence the inflammable air arises now evidently appeared not to be, as their opponents supposed, from the metal during solution parting with its phlogiston, but from the

water combined with the acid being decomposed, its oxigene uniting to the metal whilst its hydrogene is set at liberty.

Lavoisier has applied his theory of the calcination of metals to the phænomena of every other species of combustion with so happy an effect that the doctrine of phlogiston has become almost universally exploded.* That theory, which but a few years since commanded the undissenting voice of the chemical world, is now almost totally forsaken. Still however the tottering dome of this once mighty fabric is supported by one solitary pillar, so well constructed, as by its single force to uphold it against the warring elements, nor can it ever fall till this pillar is removed—Never can the doctrine of phlogiston be said to be totally destroyed, until it shall cease to rank among its supporters the name of PRIESTLEY!

I shall now present you with the last and most pleasing revolution that has occurred in chemistry. Hitherto we have beheld this science entirely in the hands of *men*; we are now about to behold *women* assert their just, though too long neglected claims, of being participators in the pleasures arising from a knowledge of chemistry. Already have Madam Dacier and Mrs. Macaulay established their rights to criticism and history. Mrs. Fulhame has now laid such bold claims to chemistry that we can no longer deny the sex

* See Note D.

the privilege of participating in this science also*. What may we not expect from such an accession of talents? How swiftly will the horizon of knowledge recede before our united labours? And what unbounded pleasure may we not anticipate in treading the paths of science with such companions?†

I shall now, gentlemen, conclude with a few observations on the utility of a general diffusion of chemical knowledge throughout America.

Living as we do in a new, extensive and unexplored country, separated by an immense ocean from all other civilized nations, we must feel ourselves deeply interested in a knowledge of *its* mineral productions, and this can only be arrived at through the medium of chemistry. As far as our very limited knowledge has yet gone, we have every reason to believe that nature has been far from bestowing her blessings on it with a parsimonious hand. Abounding as it does with the richest ores of the most valuable metals, we should be committing a crime of the blackest dye, were we through *wilful ignorance* to trample under our feet these invaluable gifts of the CREATOR.

The only true basis on which the INDEPENDENCE of our country can rest are AGRICULTURE and MANUFAC-

* Mrs. Fulhame has lately written an ingenious piece entitled "An Essay on Combustion, with a view to a new art of dying and painting, wherein the phlogistic and anti-phlogistic hypotheses are proved erroneous." Since the delivery of this oration she has been elected a corresponding member of this society.

† See note E.

TURES. To the promotion of these, nothing tends in a higher degree than chemistry. It is this science which teaches man how to correct the bad qualities of the land he cultivates by a proper application of the various species of manure, and it is by means of a knowledge of this science that he is enabled to pursue the metals through all the various forms they put on in the earth, separate them from substances which render them useless, and at length manufacture them into the various forms for use and ornament in which we see them. If such are the effects of chemistry, how much should the wish for its promotion be excited in the breast of every American! It is to a general diffusion of a knowledge of this science, next to the VIRTUE of our countrymen, that we are to look for the firm establishment of OUR INDEPENDENCE. And may your endeavours, GENTLEMEN, in this cause, entitle you to the gratitude of YOUR FELLOW-CITIZENS.

NOTES.

NOTE A—p. 15.

THE origin of alchemy cannot be traced farther back with any certainty than the second or third century of the christian era. In all probability it owed its birth to the general adoption of the proposition that “ *All bodies are but different modifications of the same primitive matter*”—the philosophers supposing that this modification might be changed at pleasure by means of certain chemical agents.

NOTE B—p. 27.

“ Rey, in the last century, ascribed the increased weight of metallic substances when they are said to have lost their phlogiston, to its true cause, the absorption of air, but on such weak grounds that he is as little entitled to the honour of a discoverer, as a successful dreamer is to that of a prophet; nor can I with justice ascribe this honour to Dr. Hales, though he extracted air from minium; as he imputed the increase of weight not only to the air, but also to sulphur which he imagined is absorbed from the fire.”

Kirwan on Phlogiston.

NOTE C—p. 28.

The almost innumerable technical terms which had been introduced into chemistry, before the formation of the new nomenclature, had for a long time been a cause of general complaint among chemists. The same substance had often eight or ten different names applied to it, most of which either conveyed no idea of its properties, or what is still worse, indicated very opposite ones to those it possessed. Within the little time that elapsed from Dr. Black's discovery of carbonic acid it had been known by the names of *Fixed Air*, *Aerial Acid*, *Mephitic Acid*, *Creaceous Acid*, &c.; but the terms *Oil of Tartar by the Bell*, *Oil of Vitriol*, *Butter of Antimony*, *Butter of Arsenic*, *Flowers of Zinc*, &c. as applied to these several compositions, are still worse, as they

serve not only to burden our memories with a useless quantity of words, but to give us a false idea of the nature of the substances they are put for; as there does not exist in the mineral kingdom, properly speaking, either *Butter, Oil, or Flowers*. A reform in the chemical nomenclature became therefore absolutely necessary to the promotion of science, or rather it became necessary, where so much error existed, to pull down the old system and erect a new one.

In 1782 M. de Morveau proposed a reformation of the nomenclature, and in 1787, M. Lavoisier, by the assistance of many of the best chemists of France, produced the following excellent plan, which is now generally adopted.

1. All those substances which cannot be separated into two or more different principles, by any known process, although they *may be* compound bodies, yet are to be considered, until an analysis can be made, as elementary, and names given to them indicating their principal properties: thus the basis of vital or pure air is called *oxigene* from the Greek words *OXUS, acid*, and *GEINOMAI, I beget*, as by a union of this substance with certain bases all the acids are formed; and the basis of *inflammable air* is called *hydrogene* from the Greek words *UDOR, water*, and *GEINOMAI, I beget*, as it is by a union of this substance with oxigene that water is formed.

2. When two simple substances are united, the name of the compound is to be so formed, by a general rule, as at once to convey the ideas of its constituent principles.

Thus all the combinations of those metals with oxigene, which do not by such an union form acids, are called by the general names of *oxides*, as in the case of the union of oxigene with lead forming red lead; which, according to the new nomenclature, is called *oxide of lead*,

According to the new theory the acids are all formed by the union of oxigene with certain bases, the names of the acids are therefore all made by giving to the names of their bases, where they are known, or when their bases are not known to the name of the source from whence they are derived, the general termination *ic*. Thus that acid formed by the union of oxigene and sulphur is called the *sulphuric acid*, and the acid procured from the *Fluor Spar*, the basis of which is unknown, is called the *glucric acid*: But there are acids the bases of which are not

fully saturated with oxygen, these are distinguished by the termination *ous*, thus when *salphur* is not quite saturated with oxygen it is called the *salphureous acid*.

3. The neutral salts are all formed by the union of the different acids with alkaline, earthy or metallic bases. Their names are made by a union of the names of the acids of which they are composed terminating with *at* when they are perfect acids, or fully saturated with oxygen, and *ite* when they are imperfect, and the names of the bases to which they are united. Thus Glauber's salts, which are formed by the union of the *salphuric acid* and *soda* are called *salphat of soda*, and a combination of the *salphureous acid* and iron, is called *salphite of iron*.

In favour of this theory of a nomenclature, little need be said, as it bears internal evidence of its utility. Of the immense quantity of technical words which are saved by it I shall give the single instance of the neutral salts.

There are at present 30 acids known, capable of forming neutral salts by their union with three alkalis, eight earths, and fourteen metals, in all 25 bases, which would make 750 different neutral salts. If to these we add those which could be formed by many of these acid in a state not fully saturated with oxygen, we shall have not far short of 1,000 different neutral salts. Allowing the former arbitrary mode of naming them to prevail, there can be no doubt that each of these salts on an average would have in the course of time at least two names, we should then have 2,000 names for them. But happily for the cause of science our memories are saved from being oppressed by this immense mass of technical rubbish by the proper application of the third rule.

For a full account of this nomenclature see the memoirs of Messrs. Lavoisier, De Morveau, Bertholet, De Fourcroy, Hassenfratz, and Adet; first published in the transactions of the academy of Science in Paris, in 1787, and since translated into English and published by Mr. St. John.

Query. Might not the nomenclature be extended to all combinations of two simple earths by using the name of the earth found in the greatest quantity as a *substantive*, and that of the one found in the least quantity as an *adjective*. Thus a stone formed by the union of a

smaller quantity of *silica* united to a greater quantity of *alumine* would be called a *silicious alumine*, whereas if the *silica* predominated it would be an *aluminous silica*. It might perhaps, be also applied to the union of a simple earth with a neutral salt, as in marble, which is composed of *alumine* and *carbonate of lime*, which would then be called *aluminous carbonate of lime*?

NOTE D.—p. 33.

Lavoisier instead of supposing with the disciples of Becher and Stahl, that all inflammable bodies possess a certain principle, which they called *phlogiston*, the giving out of which causes all the various phenomena of combustion, says that they entirely arise from the decomposition of *oxidous gas*, which is a compound body formed by the union of a certain basis with the matter of heat and light,—the basis uniting to the inflammable body while its caloric or matter of heat, and light are set at liberty. This theory they found upon the following principles.

1. Combustion is never *known* to take place without the presence of *oxigene*.

2. In every *known* combustion there is an absorption of *oxigene*.

3. There is an augmentation of weight in the products of combustion equal to the weight of the *oxigene* absorbed.

4. In all combustion there is a disengagement of light and heat.

I shall here take the liberty of suggesting the following *queries*.

QUERY 1. Should we not consider combustion as an effect of the *elective attraction* between the basis of the gas and the combustible body being stronger than that between the same basis and caloric?

QUERY 2. If so, would not the same phenomena take place were we to heat a body in any other gas whose basis has a stronger elective attraction to the body than to caloric and light, as do when such bodies are heated in *oxigene*?

QUERY 3. In the combustion of hydrogen with *oxigene* do we not find this to take place? Does not the basis of the hydrogenous gas, which was retained in a gaseous state by its union with caloric and light,

unite with the basis of the oxigenous gas, and form water, and at the same time part with its matter of heat and light?

QUERY 4. Should we conclude because those substances which burn the readiest in oxigene will not burn in any other gas, that none of them are to be found that will? Ought we not on the contrary to seek these substances among those which do not burn at all, or very slowly in this gas, as the probability is that the same substance, which has a very strong elective attraction to the basis of one gas, will have but a slight one to that of every other?

RESPIRATION may be considered as a slow species of combustion. The oxigene of the atmospheric air inhaled is decomposed, its basis unites to the blood, through the coatings of the blood vessels in the lungs, and gives it a red colour, while its matter of heat is set at liberty and forms the animal heat of the system.

NOTE E.—p. 34.

The following short extract sets chemistry, as a proper study for females, in so forcible and just a point of view that I cannot refrain from the pleasure of inserting it.

“ Chemistry is a science particularly suited to women, suited to their talents and their situation; chemistry is not a science of parade, it affords occupation and infinite variety; it demands no bodily strength, it can be pursued in retirement; it applies immediately to useful and domestic purposes; and whilst the ingenuity of the most inventive mind may be exercised, there is no danger of inflaming the imagination; the judgment is improved, the mind is intent upon realities; the knowledge that is acquired is exact, and the pleasure of the pursuit is a sufficient reward for the labour.

Letters for literary ladies

T H E E N D.

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