XV. Experiments on charcoal

Clement & Desormes

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fun, or an occultation of a fixed star. Dr. Olbers was the first who proved, in 1787, that the comets of 1532 and 1661 were totally different; consequently, that neither of them could be expected in the year 1789. Astronomy, therefore, is indebted to Dr. Olbers for having cleared up this point of so much importance. He showed how uncertain the return of these comets is; and that it is no fault in the exalted science of astronomy, if predictions, which astronomers ought never to have ventured to make, are not accomplished.

From Vienna Dr. Olbers proceeded to Prague and Dresden, and returned thence to Bremen, where he settled as a physician, and where he soon acquired the confidence of his fellow-citizens, both on account of his successful practice and of the integrity and affability of his character. Since that time astronomy has been only the amusement of his leisure hours, or a sort of recreation, to relieve and unbend the mind after the fatigue of his professional duties.

We shall add to this short sketch, that Dr. Olbers lately discovered another planet, or, perhaps, comet, for the point seems not yet determined, of which some account was given in the last two numbers of the Philosophical Magazine.

XV. *Experiments on Charcoal.* By CLEMENT and DESORMES*.

IT is generally believed that the charcoal obtained by the decomposition of organic matters still contains, notwithstanding the action of the strongest heat to which it can be subjected, some remains of the volatile principles to which it was united.

This opinion is founded upon this circumstance, that by the combustion of charcoal water is sometimes obtained, which seems to prove the presence of hydrogen; and that to form carbonic acid with charcoal less oxygen is required than with the diamond; which might induce a belief that some of it existed already in the charcoal.

The memoir published by us in the 115th number of the *Annales de Chimie*, and of which the results are nearly the same as those obtained by Mr. Cruikshank, announces the gaseous oxide of carbon as free from hydrogen.

Several chemists, convinced of the presence of hydrogen in charcoal, have supposed that this gas is a triple combination of carbon, oxygen, and hydrogen, and that its inflammability arises from the last-mentioned principle.

* From the *Annales de Chimie*, No. 125.

It appeared to us of importance to make some experiments on this subject, and we proposed the following questions:

Does hydrogen exist in charcoal when properly made?
Are the various kinds of charcoal indebted for their differences to the quantities of oxygen which they contain?

We employed two methods to come to the solution of these problems: the action of oxygen, and that of sulphur.

FIRST METHOD.

Action of Oxygen.

In our memoir on the gaseous oxide of carbon we gave an account of experiments on the combustion of charcoal in close vessels in which no water was deposited. It is, however, possible that some was produced, but that it became dissolved in the carbonic acid gas, in which a great dissolving power is generally observed.

In repeating the combustion of different kinds of charcoal properly made, but of which some remained exposed to the air, we remarked that the latter suffered a great deal of water to evaporate merely by the action of the heat, and that during their combustion it was not produced in sufficient quantity to be deposited. Those which had been carefully protected from the action of humidity exhibited no traces of it.

This proved to us that the water observed during the combustion of charcoal previously existed, and that it had been taken up by that substance, the hygrometric property of which, long known, has been confirmed by C. Guyton in the *Encyclopédie Méthodique*.

We again assured ourselves that charcoal of white wood well made*, weighing 4 grammes, by remaining exposed to the atmosphere even during dry weather, increased in weight 0.2 grammes. When heated, the water is expelled; which may be weighed, and which forms more than three-fourths of that augmentation. The remainder is air, which may be disengaged either by heat or by exposure of the charcoal in a vacuum. It may be readily conceived that these phenomena, which depend on the state of the atmosphere, the texture of the charcoal, and the time of its exposure to the air, must be exceedingly variable.

It is then certain that, if water is produced in the combustion of charcoal, it can exist only in the state of vapour in the gases which result from it.

It became a matter of importance to know what quantity of water these gases might contain. M. de Saussure

* We consider charcoal to be so, when, after a first carbonization, it has been exposed for an hour to the action of a strong furnace.

announces,

announces *, that, the temperature and pressure being equal, atmospheric air, hydrogen and carbonic acid gas, when moist affect the hair hygrometer in the same manner; but as this instrument indicates only the degree of saturation; and not the quantity of water, we thought it our duty to make some experiments for the purpose of ascertaining this quantity.

The property which concrete muriate of lime has to take moisture from the gases without altering them, induced us to make choice of it as the means of desiccation.

We made use of the apparatus generally employed. It consists of a glass tube containing the concrete muriate of lime, the weight of which is known, and through which the gas is made to pass. In order to be certain of their complete saturation, we made them pass through a jar filled with water, and placed immediately before the muriate of lime, the temperature of which was the same as that of the atmosphere and of the gases. It was always 12 or 13 degrees of the centigrade thermometer, and the pressure from 762 to 765 millimetres: the other circumstances were also as equal as possible.

The following is a table of the desiccations which we made:

Gases desiccated.	Water deposited by 36 Litres.	Water which would be de- posited by a Cubic Foot.	
	Grammes.	Grammes.	Grains.
Atmospheric Air	0.33	0.313	5.89
Oxygen Gas -	0.34	0.323	6.08
Hydrogen - -	0.34	0.323	6.08
Azote - - -	0.33	0.313	5.89
Carbonic Acid.	0.33	0.313	5.89

The carbonic acid, passing through the flask of water destined to moisten it as much as possible, would have been there dissolved; but we had previously saturated it, so that there really passed upon the muriate of lime as much of that gas as of the others.

It is here seen that the quantities of water deposited by each kind of gas were nearly the same, and the differences can be ascribed only to the unavoidable imperfection of the process. Thus it is certain that equal volumes of very different gases deposit the same quantity of water.

It remained to know whether the quantities of water which cannot be taken from gases by desiccation are equal; but it was almost impossible to ascertain this point by a

* *Essai sur l'Hygrometrie* chap. ix. of the second essay.

direct experiment, since the gases cannot be obtained perfectly dry.

From analogy we were inclined to think, that if the gases absolutely contained the same quantity of water, they ought also to contain equal quantities of the liquids which are volatilized by their contact, such as alcohol and ether.

The action of the elastic fluids on the latter being very great, it was easy to form an exact opinion of it. We therefore made experiments, from which it results, that, temperature, pressure, and other circumstances, being the same, all the gases of which we have here spoken, hydrogen as well as the carbonic acid, equally favour the evaporation of ether; that is to say, that in equal spaces occupied by any gas whatever, the same quantity of this liquid may be there reduced to the elastic state, and produce the same expansion. The case is the same with alcohol, but the quantity evaporated is much less than that of ether*.

The nature of the gas, then, has no influence on the property which they have of vaporizing ether and alcohol, as it depends only on the temperature and pressure. It is probable that the case is the same with the evaporation of water. If it were possible, indeed, to exercise on the ethereal or alcoholized gases an action similar to that of the muriate of lime on humid gases; that is to say, if the ether or alcohol could be taken away by similar means, they might be equally deprived of it; but, as we took from the gases the same quantity of water, there is great reason to presume that it is absolutely the same.

This being the case, it appears to us that if well made charcoal, not moist, be burned with dried oxygen, and if the gas produced by the combustion should not contain more water than what the absorbing salt had left in the oxygen before its being employed; that is to say, if it should pass upon a similar quantity of salt without augmenting its weight, we should be almost certain that the combustion of charcoal would produce no water: we therefore made the following experiment:

Into a very long glass tube placed upon a small furnace we introduced 4.50 grammes of charcoal of common wood heated in a furnace for an hour, and not yet cooled. To the extremities of the tube we adjusted two others containing the same quantity of muriate of lime: the latter were im-

* The interesting phenomena exhibited by the action of gases on the liquids induced us to make experiments, which we shall give an account of in another memoir.

merfed in a mixture of ice and marine falt kept constantly at 7 or 8 degrees below zero of the centigrade thermometer. To one of them was adapted an empty bladder, and to the other a fecond containing 12 litres of oxygen.

The great tube being heated, at the place where the charcoal was the gas was made to pafs; and, when the combuftion was completed, a fingle atom of water was not depofited. The tube containing the muriate of lime, which had traverfed the oxygen before it was employed, having been weighed, was found to be increafed 0.13 grammes; that is, 0.02 more than it ought to have been according to the above table of deficcations; which arofe from the cold experienced by the gas. The muriate of lime traverfed by the product of the combuftion, which ought to have contained water, was not increafed more than 0.02 grammes. This was ftill owing to the moiſture taken by the charcoal from the atmofphere at the time of its introduction into the tube. But, if we ſhould choofe to believe that this quantity was produced by the combuftion, as it contained only 0.003 grammes of hydrogen, ariſing from 4.50 grammes of charcoal, there would exiſt in 100 grammes but 0.065 grammes; that is to ſay, $\frac{1}{1552}$, a quantity inappreciable.

C. Berthollet, in a letter printed in the *Bibliothèque Britannique**, fixes at 0.0902 grammes, or 1.7 grain, the hydrogen contained in 1.9683 litres, or 100 cubic inches of inflammable gas, ariſing from the reduction of the oxide of zinc by charcoal. But this quantity of gafeous oxide of carbon weighs nearly 2.278 grammes, and contains 1.139 grammes of charcoal, and as much oxygen. This charcoal ought to contain, therefore, the 0.0902 grammes of hydrogen; that is to ſay, in 100 parts there ought to be 7.91 of hydrogen. C. Berthollet, then, has fixed higher than is indicated by experiment the quantity of hydrogen contained in carbonic acid gas, and confequently in charcoal. We have, indeed, ſeen that we can ſuppoſe in the latter body at moſt 0.065 per cent.

This experiment, made with the greateſt exactneſs poſſible, ſtill proves that 100 parts of carbonic acid conſiſt nearly of 28 parts of carbon and 72 of oxygen—a reſult given by the celebrated Lavoifier; and if he obtained water in that combuſtion, it ought not to occaſion any error in the fractions of the reſult, its exiſtence being, as we have already ſaid, anterior to the act of combuſtion.

Being deſirous to know whether all kinds of charcoal, like that of wood, might be freed by fire from all the hydrogen combined with them, we found that the charcoal of fugar,

* No 142.

wax, and animal matters, after being subjected to the action of a strong heat, were perfectly similar to common charcoal, for, like it, they produced no water by combustion. Our intention in making these experiments not only was to ascertain whether these kinds of charcoal were united with hydrogen, but also to determine the relative quantities of oxygen they might contain above that necessary to convert them into carbonic acid.

But all those kinds of charcoal above mentioned, as well as coak, plumbago, and anthracite, required nearly the same quantity of oxygen. The following is the result of the experiments:

The apparatus was the same as that employed for the combustion of the charcoal of wood. It will, perhaps, not give complete satisfaction, on account of the suspicion generally entertained of the permeability of bladders: we shall, however, observe, that those which we employed were prepared in such a manner as not to suffer the gas contained in them to escape. Besides, the results which we obtained, and of which we shall give an exact account, are so agreeable to those of Lavoisier, and to that given to us by the combustion of the charcoal of wood in a balloon filled with oxygen, that they may with certainty be depended on.

Kinds of Charcoal burnt.	Quantities employed.		Carbonic Acid,		Loss neglected.	A hundred Parts of Carbonic Acid are composed of	
	Charcoal	Oxygen.	which might to have resulted.	which actually resulted.		Charcoal	Oxygen.
	Gram.	Gram.	Gram.	Gram.	Gram.		
Charcoal of Sugar	1.63	3.93	5.56	5.46	0.10	29.3	70.7
Of Wax	1.05	2.72	3.77	3.65	0.12	27.8	72.2
Plumbago	2.44	6.36	8.80	8.80	0.00	27.8	72.2
Anthracite	2.05	5.16	7.21	7.21	0.00	28.4	71.6
Animal Charcoal	1.55	4.08	5.63	5.68	0.00	26.9	73.1

The combustion of plumbago was the most interesting. The whole was not burnt. The portion which remained had become of a pale black colour exactly like charcoal: at some parts of its surface it appeared that the texture of its parts had become less compact, and that the black colour was entirely owing to this attenuation.

Many

Many substances which have a fine splendour become tarnished when scraped: oxygen, by scratching, as we may say, the plumbago, produces in it small vacuities which disperse the rays of light, and suffering them no longer to be reflected towards the eye but in a small quantity: they therefore produce only a weak sensation, and the body is judged to be tarnished.

Besides this experiment, in which the black colour generally observed in the carbonaceous principle seems to us to be owing to its division and its texture, we have had occasion to see the charcoal of turpentine and wax, which are commonly so black and dull, become brilliant like plumbago when their parts became more compact.

It is known that Priestley, that illustrious observer, was acquainted with this charcoal of turpentine, and which he positively called white charcoal.

Thus charcoal, whatever be its texture or colour, if it has been heated, is always the same, contains no hydrogen, and requires for its combustion the same quantity of oxygen. The alkaline or earthy matters, which may vary the carbonaceous principle without making any change in it, is not considered.

These experiments, indeed, do not prove that the diamond does not make an exception; but they give us reason to wish for a new combustion of that body, which is too dear to be subjected to this process on a large scale.

[To be continued.]

XVI. Notices respecting New Books.

Philosophical Transactions of the Royal Society of London for the Year 1802. Part i.

THE present part, which is extremely interesting, contains as follow:—1. The Croonian Lecture. On the Power of the Eye to adjust itself to different Distances when deprived of the Crystalline Lens. By Everard Home, Esq. F.R.S.—2. The Bakerian Lecture. On the Theory of Light and Colours. By Thomas Young, M.D. F.R.S. Professor of Natural Philosophy in the Royal Institution.—3. An Analysis of a mineral Substance from North America, containing a Metal hitherto unknown. By Charles Hatchett, Esq. F.R.S.—4. A Description of the Anatomy of the *Ornithorynchus paradoxus*. By Everard Home, Esq. F.R.S.—5. On the Independence of the analytical and geometrical Methods of Investigation; and on the Advantages to be derived