

II. "Absorption of Gases by Charcoal. Part II. On a new Series of Equivalents or Molecules." By R. ANGUS SMITH, Ph.D., F.R.S. Received January 30, 1879.

(Abstract.)

In the "Transactions of the British Association," 1868, Norwich, on page 64 of the "Abstracts," there is a preliminary notice of an investigation into the amount of certain gases absorbed by charcoal. I made the inquiry from a belief previously expressed in a paper of which an abstract is in the "Proceedings of the Royal Society," page 425, for 1863. I said in that paper that the action of the gas and charcoal was on the border line between physics and chemistry, and that chemical phenomena were an extension of the physical; also that the gases were absorbed by charcoal in whole volumes, the exceptions in the numbers being supposed to be mistakes. The results given were:—

Hydrogen .....	1
Oxygen .....	7.99
Carbonic oxide.....	6.03
Carbonic acid .....	22.05
Marsh-gas.....	10.01
Nitrous oxide .....	12.90
Sulphurous acid .....	36.95
Nitrogen .....	4.27

It was remarked that the number for nitrogen was probably too low; I had some belief that the charcoal retained a certain amount which I had not been able to estimate.

For common air, the number 40.065 crept into the paper or abstract instead of the quotient 7.06.

I considered the numbers very remarkable, but was afraid that they would be of little interest unless they could be brought more easily under the eyes of others; my experiments were somewhat laborious; the exact numbers were seldom approached by the single analysis, but were wholly the result of a series of irregular averages and apparently irregular experiments. The cause of this was clear, as I believed, namely, the irregular character of the charcoal with which I had to deal. The experiments which I had published were forgotten, I suppose, by most men, but the late Professor Graham told me that he had repeated them with the same results which I had given. I might have considered this sufficient, but waited for time to make a still more elaborate investigation of the subject, and to take special care with oxygen, in the belief that, the rule being found,

the rest of the inquiry would be easy; this was extended to nitrogen, but not by so many experiments as with oxygen. I am now assured of a sound foundation for inquiries, which must take their beginning from the results here given.

It is found that charcoal absorbs gases in definite volumes, the physical action resembling the chemical.

Calling the volume of hydrogen absorbed 1, the volume of oxygen absorbed is 8. That is, whilst hydrogen unites with eight times its weight of oxygen to constitute water, charcoal absorbs eight times more oxygen by volume than it absorbs hydrogen. No relation by volume has been hitherto found the same as the relation by weight.

The specific gravity of oxygen being 16 times greater than hydrogen, charcoal absorbs 8 times 16, or 128 times more oxygen by weight than it does hydrogen. This is equal to the specific gravity of oxygen squared and divided by two  $\frac{16^2}{2}$ , or it is the atomic weight and specific gravity multiplied into each other,  $16 \times 16$ , and divided by two  $\frac{256}{2} = 128$ .

Nitrogen was expected to act in a similar way, but it refused. The average number of the latest inquiry is 4.52, but the difficulty of removing all the nitrogen from charcoal is great, and I suppose the correct number to be 4.66. Taking this one as the weight absorbed,  $14 \times 4.66 = 65.3$ , or it is  $\frac{14^2}{3}$ . Oxygen is a dyad; nitrogen a triad.

We have then carbonic acid not divided, but simply 22 squared = 484.

Time is required for full speculation, but the chemist must be surprised at the following:—

Carbonic oxide .....	6	volumes.	
Carbonic acid, CO <sub>2</sub> .....	6 + 16	„	= 22
Marsh-gas, CH <sub>4</sub> .....	6 + 4	„	= 10
Protoxide of nitrogen, NO .....	8 + 4.66 (N)	(4.9)	12.466.

These four results belong to the early group not corroborated lately, but so remarkably carrying out the principle of volume in this union giving numbers the same as those of weight in chemical union, that they scarcely require to be delayed.

I am not willing to theorize much on the results; it is here sufficient to make a good beginning. We appear to have the formation of a new series of molecules made by squaring our present chemical atoms, and by certain other divisions peculiar to the gases themselves. Or it may be that the larger molecule exists in the free gas, and chemical combination breaks it up. These new and larger molecules may lead us to the understanding of chemical combinations in organic chemistry,

and whenever there is union not very firm, and may also modify some of our opinions on atomic weights and the motion of gases.

Of course, I cannot pretend to give the result of these results; but as we have here the building up of a molecule by volumes, so as to form an equivalent of physical combination analogous to the chemical equivalent, it is impossible to avoid seeing that it indicates the possibility of our present equivalents being made up in a similar manner.

I did not expect these numbers; but I certainly, as my previous paper showed, had in full view a necessity for some connexion between physical and chemical phenomena more decided than we possessed.

*February 13, 1879.*

W. SPOTTISWOODE, M.A., D.C.L., President, in the Chair.

The Presents received were laid on the table and thanks ordered for them.

The following Papers were read:—

- I. "Note on the Development of the Olfactory Nerve and Olfactory Organ of Vertebrates." By A. MILNES MARSHALL, M.A., D.Sc., Fellow of St. John's College, Cambridge. Communicated by W. S. SAVORY, F.R.S., Surgeon to and Lecturer on Surgery at St. Bartholomew's Hospital. Received January 30, 1879.

In the course of an investigation into the development of the cranial nerves of the chick, certain facts came to light indicating that the olfactory nerve, instead of being, as usually described, a structure differing totally in its mode of origin from all the other nerves in the body, in reality "exactly corresponds in mode of development and in appearance with the other cranial nerves, and with the posterior roots of the spinal nerves."\*

The present paper contains the results of further investigations on this point; it deals also with some features in the development of the vertebrate olfactory organ, and with certain questions of a more general nature affected by the conclusions arrived at.

\* "Proc. Roy. Soc.," vol. xxvi, p. 50, and "Quarterly Journal of Microscopical Science," January, 1878, pp. 17-23.