William Prout (1785-1850)

On the Relation between the Specific Gravities of Bodies in their Gaseous State and the Weights of their Atoms.

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The author of the following essay submits it to the public with the greatest diffidence; for though he has taken the utmost pains to arrive at the truth, yet he has not that confidence in his abilities as an experimentalist as to induce him to dictate to others far superior that its importance will be seen, and that some one will undertake to examine it, and thus verify or refute its conclusions. If these should be proved erroneous, still new facts may be brought to light, or old ones better established, by the investigation; but if they should be verified, a new and interesting light will be thrown upon the whole science of chemistry.

It will perhaps be necessary to premise that the observations about to be offered are chiefly founded on the doctrine of volumes as first generalized by M. Gay-Lussac; and which, as far as the author is aware at least, is now universally admitted by chemists.

On the Specific Gravities of the Elementary Gases.

1. *Oxygen and Azote*.-- Chemists do not appear to have considered atmospheric air in the light of a compound formed upon chemical principles, or at least little stress has been laid upon this circumstance. It has, however, been long known to be constituted by bulk of four volumes of azote and one volume of oxygen; and if we consider the atom of oxygen as 10, and the atom of azote as 17.5, it will be found by weight to consist of one atom of oxygen and two atoms of azote, or per cent. of

Oxygen	22.22
Azote	77.77

Hence, then, it must be considered in the light of a pure chemical compound; and indeed nothing but this supposition will account for its uniformity all over the world, as demonstrated by numerous experiments. From these data the specific gravities of oxygen and azote (atmospheric air being 1.000) will be found to be,[1]

Oxygen	1.1111
Azote	.9722

2. *Hydrogen*.-- The specific gravity of hydrogen, on account of its great levity, and the obstinacy with which it retains water, has always been considered as the most difficult to take of any other gas. These obstacles made me (to speak in the first person) despair of arriving at a more just conclusion than had been before obtained by the usual process of weighing; and it occurred to me that its specific gravity might be much more accurately obtained by calculation from the specific gravity of a denser compound into which it entered in a known proportion. Ammoniacal gas appeared to be the best suited to my purpose, as its specific gravity has been taken with great care by Sir H. Davy, and the chance of error had been much diminished from the slight difference between its sp. gr. and that of steam. Moreover, Biot and Arrago had obtained almost precisely the same result as Sir H. Davy. The sp. gr. of ammonia, according to sir H. Davy, is .590164, atmospheric air being 1.000. We shall consider it as .5902; and this we are authorized in doing, as Biot and Arrago state it somewhat higher than Sir H. Davy. Now ammonia consists of three volumes of hydrogen and one volume of azote condensed into two volumes. Hence the sp. gr. of hydrogen will be found to be .0694,[2] atmospheric air being 1.0000. It will be also observed that the sp. gr. of oxygen as obtained above is just 16 times that of hydrogen as now ascertained, and the sp. gr. of azote just 14 times.[3]

3. Chlorine. The specific gravity of muriatic acid, according to Sir H. Davy's experiments, which coincide exactly with those of Biot and Arrago, is 1.278. Now if we suppose this sp. gr. to be erroneous in the same proportion that we found the sp. gr. of oxygen and azote to be above, (which, though not rigidly accurate, may yet be fairly done, since the experiments were conducted in a similar manner), the sp. gr. of this gas will come out about 1.2845;[4] and since it is a compound of one volume chlorine and one volume hydrogen, the specific gravity of chlorine will be found by calculation to be 2.5.[5] Dr. Thomson states, that he has found 2.483 to be near the truth,[6] and Gay-Lussac almost coincides with him.[7] Hence there is every reason for concluding that the sp. gr. of chlorine does not differ much from 2.5. On this supposition, the sp. gr. of chlorine will be found exactly 36 times that of hydrogen.

On the Specific Gravities of Elementary Substances in a Gaseous State that do not at ordinary Temperatures exist in that State.

1. *Iodine*. I had some reason to suspect that M. Gay-Lussac had in his excellent memoir rated the weight of an atom of this substance somewhat too high; and in order to prove this 50 grains of iodine, which had been distilled from lime, were digested with 30 grs. of very pure lamellated zinc. The solution formed was transparent and colourless; and it was found that 12.9 grains of zinc had been dissolved. 100 parts of iodine, therefore, according to this experiment, will combine with 25.8 parts of zinc, and the weight of an atom of iodine will be 155,[8] zinc being supposed to be 40. From these data, the sp. gr. of iodine in a state of gas will be found by calculation to be 8.611111, or exactly 124 times that of hydrogen.[9]

2. *Carbon*. I assume the weight of an atom of carbon at 7.5. Hence the sp. gr. of a volume of it in a state of gas will be found by calculation to be .4166, or exactly 12 times that of hydrogen.

3. *Sulphur*.-- The weight of an atom of sulphur is 20. Hence the specific gravity of its gas is the same as that of oxygen, or 1.1111, and consequently just 16 times that of hydrogen.

4. *Phosphorus*.-- I have made many experiments in order to ascertain the weight of an atom of this substance; but, after all, have not been able to satisfy myself, and want of leisure will not permit me to pursue the subject further at present. The results I have obtained approached nearly to those given by Dr. Wollaston, which I am therefore satisfied are correct, or nearly so, and which fix phosphorus at about 17.5, and phosphoric acid at 37.5,[10] and these numbers at present I adopt.

5. *Calcium*.-- Dr. Marcet found carbonate of lime composed of 43.9 carbonic acid and 56.1 lime.[11] Hence as 43.9:56.1::27.5:35.1, or 35 very nearly; and 35 - 10 = 25, for the atom of calcium. The sp. gr. of a volume of its gas will therefore be 1.3888, or exactly 20 times that of hydrogen.

6. *Sodium*.-- 100 grains of dilute muriatic acid dissolved 18.6 grs. of carbonate of lime, and the same quantity of the same dilute acid dissolved only 8.2 grs. of carbonate of lime, after there had been previously added 30 grs. of a very pure crystallized subcarbonate of soda. Hence 30 grs. of crystallized subcarbonate of soda are equivalent to 10.4 grs. of carbonate of lime, and as 10.4:30::62.5:180. Now 100 grs. of crystallized subcarbonate of soda were found by application of heat to lose 62.5 of water. Hence 180 grs. of the same salt contain 112.5 of water, equal to 10 atoms, and 67.5 dry subcarbonate of soda, and 67.5 - 27.5 = 40 for the atom of soda, and 40 - 10 = 30 for the atom of sodium. Hence a volume of it in a gaseous state will weigh 1.6666, or exactly 24 times that of hydrogen.

7. *Iron*.-- 100 grs. of dilute muriatic acid dissolved as before 18.6 grs. of carbonate of lime, and the same quantity of the same acid dissolved 10.45 of iron. Hence as 18.6:10.45::62.5:35.1, or for the sake of analogy, 35, the weight of an atom of iron. The sp. gr. of a volume of this metal in a gaseous state will be 1.9444, or exactly 28 times that of hydrogen.

8. *Zinc*.-- 100 grs. of the same dilute acid dissolved, as before, 18.6 of carbonate of lime and 11.85 of zinc. Hence as 18.6:11.85::62.5:39.82, the weight of the atom of zinc, considered from analogy to be 40. Hence the sp. gr. of a volume of it in a gaseous state will be 2.222, or exactly 32 times that of hydrogen.

9. *Potassium*.-- 100 grs. of the same dilute acid dissolved, as before, 18.6 carbonate of lime; but after the addition of 20 grs. of super-carbonate of potash, only 8.7 carbonate of lime. Hence 20 grs. of super-carbonate of potash are equivalent to 9.9 carbonate of lime; and as 9.9:20::62.5:126.26, the weight of the atom of super-carbonate of potash. Now 126.26 - (55 + 11.25) = 60, the weight of the atom of potash, and 60 - 10 = 50, the weight of the atom of potassium. Hence a volume of it in a state of gas will weigh 2.7777, or exactly 40 times as much as hydrogen.

10. *Barytium*.-- 100 grs. of the same dilute acid dissolved exactly as much again of carbonate of barytes as of carbonate of lime. Hence the weight of the atom of carbonate of barytes is 125; and 125 - 27.5 = 97.5, the weight of the atom of barytium. The sp. gr. therefore, of a volume of its gas will be 4.8611, or exactly 70 times that of hydrogen.

With respect to the above experiments, I may add, that they were made with the greatest possible attention to accuracy, and most of them were many times repeated with almost precisely the same results.

The following tables exhibit a general view of the above results, and at the same time the proportions, both in volume and weight, in which they unite with oxygen and hydrogen: also the weights of other substances, which have not been rigidly examined, are here stated from analogy.

TABLE I.-- *Elementary Substances.*

Name.	Sp. gr. hydr. being 1.	Wt. of atom, 2 vols. hydr. being 1.	Wt. of atom, oxygen being 10.	Wt. of atom, oxygen being 10, from experiment.	Sp. gr. atmospheric air being 1.	Sp. gr. atmospheric air being 1, from experiment.	Wt. in grs. of 100 cub. inches. Barom. 30, Therm. 60.	Wt. in grs. of 100 cub. in. from exper.	Observations.
Hydrogen	1	1	1.25	1.32	.06944	.073(1)	2.118	2.23	(1)Dr.Thomson. See *Annals of Philosophy*, i. 177.
Carbon	6	6	7.5	7.54(2)	.4166	--	12.708	--	(2)Dr. Wollaston, from Biot and Arrago. Phil. Trans. civ. 20. Dr. Thomson makes it 7.51. *Annals of Philosophy*, ii. 42.
Azote	14	14	17.5	17.54	.9722	.969(3)	29.652	29.56	(3)Dr. W. from Biot and Arrago.
Phosphorus	14	14	17.5	17.4(4)	.9722	--	29.652	--	(4)Dr. W. from Berzelius and Rose.
Oxygen	16	8	10	10	1.1111	1.104(5)	33.888	33.672	(5)Dr. Thomson, from a mean of several experiments.
Sulphur	16	16	20	20(6)	1.1111	--	33.888	--	(6)Dr. W. from Berzelius.
Calcium	20	20	25	25.46(7)	1.3888	--	42.36	--	(7)Dr. W. from experiment.
Sodium	24	24	30	29.1(8)	1.6666	--	50.832	--	(8)Dr. W. from Davy.
Iron	28	28	35	34.5(9)	1.9444	--	59.302	--	(9)Dr. W. from Thenard and Berzelius.
Zinc	32	32	40	41(10)	2.222	--	67.777	--	(10)Dr. W. from Gay-Lussac.

Chlorine	36	36	45	44.1[11]	2.5	2.483[12]	76.248	--	[11]Dr. W. from Berzelius. [12]Quoted from Dr. Thomson, *Annals of Philosophy*, iv. 13.
Potassium	40	40	50	49.1[13]	2.7777	--	84.72	--	[13]Dr. W. from Berzelius
Barytium	70	70	87.5	87[14]	4.8611	--	148.26	--	[14]Dr. W. from Berzelius and Klaproth.
Iodine	124	124	155	156.21[15]	8.6111	--	262.632	--	[15]Gay-Lussac. Ann. de Chim. xci. 5.

TABLE II.-- ***Combinations with Oxygen*.**

Name.	Sp. gr. hydro. being 1.	Wt. of atom, 2 vol. hydro. being 1.	Wt. of atom, ox. being 10.	Wt. of atom, ox. being 10, from exper.	Sp. gr. atmos. air being 1	Sp. gr. atmos. air being 1, from exper.	Wt. of 100 cu. in. Bar. 30, Ther. 60.	Wt. of 100 cu. in. from exp.	Elements by volume.	No. of vol. after combination.	Elements by weight.	Observations
Water	9	9	11.25	11.32	.625	.6896[1]	19.062	21.033	.5 ox + 1 hyd	1	1 ox + 1 hy	[1]Trales, Dr. Thomson, *Annals*, i. 177.
Carbonic oxyde	14	14	17.5	17.54	.9722	.956[2]	29.652	29.16	.5 ox + 1 ca	1	1 ox + 1 car	[2]Cruikshanks, quoted by Thomson.
Nitrous oxyde	22	22	27.5	--	1.5277	1.614[3]	46.596	49.227	.5 ox + 1 az	1	1 ox + 1 az	[3]Sir H. Davy.
Atmospheric air	14.4	36	45	--	1.000	1.000	30.5	30.5[4]	.5 ox + 2 az	2.5	1 ox + 2 az	[4]Sir G. S. Evelyn
Phosphorous acid									.5 ox + 1 ph ?		1 ox + 1 ph ?	
Oxyde of sulphur?									.5 ox + 1 sul ?		1 ox + 1 sul ?	
Euchlorine	44	44	55		3.0555	2.409[5]	93.192	73.474	.5 ox + 1 ch	1 ?	1 ox + 1 ch	[5]Sir H. Davy.
									.5 ox + 1 iod		1 ox + 1 iod	
Lime	28	28	35	35.46	1.9444	--	59.304	--	.5 ox + 1 cal		1 ox + 1 cal	
									&c.		&c.	
									1 ox + 1 hy[6]		2 ox + 1 hy	[6]This and all higher combinations of hydrogen with oxygen are unknown.
Carbonic acid	22	22	27.5	27.54	1.5277	1.518[7]	46.596	46.313	1 ox + 1 car	1	2 ox + 1 car	[7]Saussure.
Nitrous gas	15	30	37.5		1.0416	1.0388[8]	31.77	31.684	1 ox + 1 az	2	2 ox + 1 az	[8]Berard.
Phosphoric acid	30	30	37.5	37.4	2.0832	--	63.54	--	1 ox + 1 ph		1 ox + 1 ph	
Sulphurous acid	32	32	40		2.2222	2.193[9]	67.777	66.89	1 ox + 1 sul	1	2 ox + 1 sul	[9]Sir H. Davy.
									1 ox + 1 ch		2 ox + 1 ch	
									1 ox + 1 iod		2 ox + 1 iod	
									&c.		&c.	

									1.5 ox + 1 car		3 ox + 1 car	
Nitrous acid	38	38	47.5		2.6388	2.427[10]	80.484	74.0234	1.5 ox + 1 az	1	3 ox + 1 az	[10]Sir H. Davy.
									1.5 ox + 1 ph		3 ox + 1 ph	
Sulphuric acid	40	40	50	50	2.7777		84.72		1.5 ox + 1 sul	1	3 ox + 1 sul	
									1.5 ox + 1 ch		3 ox + 1 ch	
									1.5 ox + 1 iod		3 ox + 1 iod	
									&c.		&c.	
									&c.		&c.	
									2.5 ox + 1 car		5 ox + 1 car	See Gay-Lussac's memoir on iodine above referred to.
Nitric acid	54	54	67.5	67.54	3.75		114.372		2.5 ox + 1 az	1	5 ox + 1 az	
									2.5 ox + 1 ph		5 ox + 1 ph	
									2.5 ox + 1 sul		5 ox + 1 sul	
Chloric acid	76	76	95		5.2777	--	160.968		2.5 ox + 1 ch		5 ox + 1 ch	
Iodic acid	164	164	205		11.3883		347.352		2.5 ox + 1 iod		5 ox + 1 iod	
									&c.		&c.	

TABLE III.-- ***Compounds with Hydrogen*.**

Name.	Sp. gr. hydro. being 1	Wt. of atom, 2 vol. hydr. being 1.	Wt. of atom, oxygen being 10.	Wt. of atom, oxygen being 10, from experiment.	Sp. gr. atmospheric air being 1.	Sp. gr. atmospheric air being 1, from experiment.	Wt. of 100 cub. inch. Bar. 30. Ther. 60.	Wt. of 100 cub. inch. from exper.	Elements by volume.	No. of vol. after combination.	Elements by weight.	Observations.
Carbureted hydrogen	8	7	8.75	8.86	.5555	.5555[1]	16.999	16.999	2 hy + 1 car	1	1 hy + 1 car	[1]Dr. Thomson.
Olefiant gas	14	13	16.25	16.4	.9722	.974[2]	29.652	29.72	2 hy + 2 car	1	1 hy + 2 car	[2]Ditto.
Hydro-phosphorus gas												I have omitted these from the uncertainty that still hangs over phosphorus.
Phosphoreted hydrogen												
									1 hy + 1 az		.5 hy + 1 az	This compound is at present unknown, but it probably exists in fulminating gold, silver, &c. united to these metals.
Ammonia	8.5	15.5	19.375	21.5[3]	.5902	.59[3]	18.003	18.00	3 hy + 1 az	2	1.5 hy + 1 az	[3]Dr. Wollaston.

Sulphureted hydrogen	17	16.5	20.625	20.66	1.1805	1.177[4]	36.006	35.89	1 hy + 1 sul	1	.5 hy + 1 sul	[4]Sir H. Davy.
Muriatic acid	18.5	36.5	45.625	45.66	1.284	1.278[5]	39.183	38.979	1 hy + 1 ch	2	.5 hy + 1 ch	[5]Ditto.
Hydriodic acid	62.5	124.5	155.625	155.66	4.3402	4.3463[6]	132.375		1 hy + iode	2	.5 hy + 1 iod	[6]Gay-Lussac.

TABLE IV.-- Substances stated from Analogy, but of which we are yet uncertain.

Name.	Sp. gr. hydro being 1.	Wt. of atom, 2 vol. hydr. being 1.	Wt. of atom, oxygen being 10.	Wt. of atom, oxygen being 10, from exper.	Observations.
Aluminium	8	8	10	10.68[1]	[1]Berzelius.
Magnesium	12	12	15	14.6[2]	[2]Henry. Berzelius makes it 15.77.
Chromium	18	18	22.5	23.6[3]	[3]Berzelius.
Nickel	28	28	35	36.5[4]	[4]Ditto.
Cobalt	28	28	35	36.6[5]	[5]Rolhoff.
Tellurium	32	32	40	40.27[6]	[6]Berzelius.
Copper	32	32	40	40[7]	[7]As deduced by Dr. Thomson.
Strontium	48	48	60	59[8]	[8]Klaproth.
Arsenic	48	48	60	60[9]	[9]Berzelius.
Molybdenum	48	48	60	60.13[10]	[10]Bucholz and Berzelius.
Manganese	56	56	70	71.15[11]	[11]Berzelius.
Tin	60	60	75	73.5[12]	[12]Ditto.
Bismuth	72	72	90	89.94[13]	[13]Ditto.
Antimony	88	88	110	111.11[14]	[14]Ditto. Dr. Thomson makes it 112.49.
Cerium	92	92	115	114.87[15]	[15]Hisinger.
Uranium	96	96	120	120[16]	[16]Bucholz.
Tungsten	96	96	120	121.21[17]	[17]Berzelius.
Platinum	96	96	120	121.66[18]	[18]Ditto.
Mercury	100	100	125	125[19]	[19]Fourcroy and Thenard.
Lead	104	104	130	129.5[20]	[20]Berzelius.
Silver	108	108	135	135[21]	[21]Wenzel and Davy.
Rhodium	120	120	150	149.03[22]	[22]Berzelius.
Titanium	144	144	180	180.1[23]	[23]Ditto.
Gold	200	200	250	249.68[24]	[24]Ditto.

Observations.

Table I.-- This, as well as the other tables, will be easily understood. In the first column we have the specific gravities of the different substances in a gaseous state, hydrogen being 1: and if we suppose the volume to be 47.21435 cubic inches, the numbers will at the same time represent the number of grains which this quantity of each gas will weigh. In the third column are the corrected numbers, the atom of oxygen being supposed, according to Dr. Thomson, Dr. Wollaston, &c. to be 10: and in the fourth, the same, as obtained by experiment, are stated, to show how nearly they coincide. Of the individual substances mentioned, I have no remark to make, except with respect to iodine. I made but one experiment to ascertain the weight of the atom of this substance, and therefore the results stated may be justly considered as deserving but little confidence; and indeed this would be the case, did not all the experiments of Gay-Lussac nearly coincide in the same.

Table II.-- This table exhibits many striking instances of the near coincidence of theory and experiment. It will be seen that Gay-Lussac's views are adopted, or rather indeed anticipated, as a good deal of this table was drawn up before I had an opportunity of seeing the latter part of that chemist's memoir on iodine. That table also exhibits one or two striking examples of the errors that have arisen from not clearly understanding the relation between the doctrine of volumes and of atoms. Thus ammonia has been stated to be composed of one atom of azote and only 1.5 of hydrogen, which are condensed into two volumes, equal therefore to one atom; and this is the reason why this substance, like some others, apparently combine in double proportions.[12]

Table III.-- This table likewise exhibits some striking examples of the coincidences above noticed. Indeed, I had often observed the near approach to round numbers of many of the weights of the atoms, before I was led to investigate the subject. Dr. Thomson appears also to have made the same remark. It is also worthy of observation, that the three magnetic metals, as noticed by Dr. Thomson, have the same weight, which is exactly double that of azote. Substances in general of the same weight appear to combine readily, and somewhat resemble one another in their nature.

On a general review of the tables, we may notice,
1. That all the elementary numbers, hydrogen being considered as 1, are divisible by 4, except carbon, azote, and barytium, and these are divisible by 2, appearing therefore to indicate that they are modified by a higher number than that of unity or hydrogen. Is the other number 16, or oxygen? And are all substances compounded of these two elements?
2. That oxygen does not appear to enter into a compound in the ratio of two volumes or four atoms.
3. That all the gases, after having been dried as much as possible, still contain water, the quantity of which, supposing the present views are correct, may be ascertained with the greatest accuracy.

Others might doubtless be mentioned; but I submit the matter for the present to the consideration of the chemical world.

[Notes: --CJG]

[1]Let x = sp. gr. of oxygen. 22.22 = a
y = sp. gr. of azote. 77.77 = b
Then (x+4y)/5 = 1.
And x:4y::a:b.
Hence 5-4y = 4ay/b
And y = 5b/(4a+4b) = .9722. And x = 5-4y = 1.11111.

[2]Let x = sp. gr. of hydrogen.
Then (3x+.9722)/2 = .5902.
Hence x = (1.1804-.9722)/3 = .0694.

[3]1.11111 / .0694 = 16. And .9722 / .0694 = 14.

[4]As 1.104:1.11111::1.278:1.286.
And as .969:.9722::1.278:1.283. The mean of these is 1.2845.

[5]Let x = sp. gr. of chlorine.
Then (x+.0694)/2 = 1.2845.
And x = 2.569-.0694 = 2.5 very nearly.

[6]*Annals of Philosophy*, vol. iv. p. 13.

[7]Ditto, vol. vi. p. 126.

[8]As 25.8:100::40:155. According to experiment 8th, stated below, the weight of an atom of zinc is 40. Dr. Thomson makes it 40.9, which differs very little. See *Annals of Philosophy*, vol. iv. p. 94.

[9]One volume of hydrogen combines with only half a volume of oxygen, but with a whole volume of gaseous iodine, according to M. Gay-Lussac. The ratio in volume, therefore, between oxygen and iodine is as 1/2 to 1, and the ratio in weight is as 1 to 15.5. Now .5555, the density of half a volume of oxygen, multiplied by 15.5, gives 8.61111, and 8.61111 / .06944 = 124. Or generally, to find the sp. gr. of any substance in a state of gas, we have only to multiply half the sp. gr. of oxygen by the weight of the atom of the substances with respect to oxygen. See *Annals of Philosophy*, vol. v. p. 105.

[10]Some of my experiments approached nearer to 20 phosphorus and 40 phosphoric acid.

[11]I quote on the authority of Dr. Thomson, *Annals of Philosophy*, vol. iii, p. 376. Dr. Wollaston makes it somewhat different, or that carbonate of lime consists of 43.7 acid and 56.3 lime. Phil. Trans. vol. civ. p. 8.

[12]See Gay-Lussac's memoir on iodine, *Annals of Philosophy*, vi. 189.

Correction of a Mistake in the Essay on the Relation between the Specific Gravities of Bodies in their Gaseous State and the Weights of their Atoms

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The author of the essay On the Relation between the Specific Gravities of Bodies in their Gaseous State and the Weights of their Atoms is anxious to correct an oversight which influences some of the numbers in the third table given in that essay (vol. vi. p. 328). This oversight will be found in the head or title of the third column in each table, and consists in the statement of the atom of hydrogen being composed of two volumes instead of one, upon which latter supposition the tables are actually constructed, except in the instances corrected in the third table as follows, and in a sentence in the first paragraph on p. 330, beginning "This table also exhibits," &c. which is to be expunged.

Name.	Sp. gr. hydro. being 1	Wt. of atom, hydrogen being 1.	Wt. of atom, oxygen being 10.	Wt. of atom, oxygen being 10, from experiment.	Sp. gr. atmospheric air being 1.	Sp. gr. atmospheric air being 1, from experiment.	Wt. of 100 cub. inch. Bar. 30. Ther. 60.	Wt. of 100 cub. inch. from exper.	Elements by volume.	No. of vol. after condensation.	Elements by weight.	Observations.
Carburetted hydrogen	8	4	5	5.09	.5555	.5555(1)	16.999	16.999	1 hyd + .5 car	.5	1 hyd + .5 car	(1)Dr. Thomson.
Olefiant gas	14	7	8.75	8.86	.9722	.9740(1)	29.652	29.72	1 hyd + 1 car	.5	1 hyd + 1 car	
Sulphureted hydrogen	17	17	21.25	21.32	1.1805	1.177	36.006	35.89	1 hyd + 1 sul	1	1 hyd + 1 sul	
Muriatic acid	18.5	37	46.25	45.42	1.284	1.278	39.183	38.979	1 hyd + 1 chl	2	1 hyd + 1 chl	
Hydriodic acid	62.5	125	156.25	157.53	4.3402	4.3463(2)	132.375	--	1 hyd + 1 iod	2	1 hyd + 1 iod	(2)Gay-Lussac.
Ammonia	8.5	17	21.25	21.5(3)	.5902(4)	.5900	18.003	18.000	3 hyd + 1 az	2	3 hyd + 1 az	(3)Dr. Wollaston. (4)Sir H. Davy.
Cyanogen	26	26	32.5	32.52	1.8055	1.8064(5)	55.068	--	2 car + 1 az	1	2 car + 1 az	(5)Gay-Lussac. Ann. de Chim. Aug. 1815.
Hydro-cyanic acid	13.5	27	33.75	33.846	.9374	.9360(5)	28.593	--	1 cya + 1 hy	2	1 cya + 1 az	
Chloro-cyanic acid	31	62	77.5	--	2.1527	2.1111(5)	65.659	--	1 cya + 1 chl	2	1 cya + 1 chl	

In this table it will be also observed that the new determinations of Gay-Lussac respecting the prussic acid, &c. are inserted, to show that they correspond with, and further corroborate, the views which have been brought forward in the essay above referred to.

There is an advantage in considering the volume of hydrogen equal to the atom, as in this case the specific gravities of most, or perhaps all, elementary substances (hydrogen being 1) will either exactly coincide with, or be some multiple of, the weights of their atoms; whereas if we make the volume of oxygen unity, the weights of the atoms of most elementary substances, except oxygen, will be double that of the specific gravities of bodies in their gaseous state (either with respect to hydrogen or atmospheric air), by means of Dr. Wollaston's logometric scale.

If the view we have ventured to advance be correct, we may almost consider the πρωτη υλη of the ancients to be realised in hydrogen; an opinion, by the by, not altogether new. If we actually consider this to be the case, and further consider the specific gravities of bodies in their gaseous state to represent the number of volumes condensed into one; or, in other words, the number of the absolute weight of a single volume of the first matter (πρωτη υλη) which they contain, which is extremely probable, multiples in weight must always indicate multiples in volume, and *vice versa*; and the specific gravities, or absolute weights of all bodies in a gaseous state, must be multiples of the specific gravity or absolute weight of the first matter (πρωτη υλη), because all bodies in a gaseous state which unite with one another unite with reference to their volume.

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