

a molecule of chlorine formed of two atoms will likewise occupy two volumes. What now will happen when chlorine combines with hydrogen? The molecules will be cut in two, and each of the two chlorine atoms uniting itself to an atom of hydrogen, two molecules of hydrochloric acid will be formed, each occupying "two" volumes. Thus if an atom of hydrogen occupies one volume, a molecule of hydrochloric acid will occupy two volumes. The same is the case with the molecules of all other gases and vapors.

A molecule of water formed of $\frac{1}{2}$ H and 1 at. O } occupies 2 volumes.
 ammonia " $\frac{1}{2}$ " 1 at. N }
 marsh gas " 4: " 1 at. C } volumes.

This list might be prolonged by taking as examples a large number of gaseous or volatile bodies belonging both to mineral and to organic chemistry, and including chlorinated, brominated, and oxygenated compounds of the metalloids, and of a large number of metals. The countless volatile compounds of organic chemistry, hydrocarbons, alcohols, chlorides, bromides, organo-metallic compounds, compound ammonias, aldehydes, ketones—all this legion of various compounds—conform to the law of Avogadro and Ampère, their molecules occupying two volumes if an atom of hydrogen occupies one volume. Hence it follows that the relative weights of two volumes represent the relative weights of the molecules, or the molecular weights. To find these latter, therefore, it is sufficient to double the numbers which express the weights of a single volume, or of the unit of volume, that is to say, the densities. The densities of gases may be referred to that of hydrogen as unity, and the atomic weights to that of hydrogen. The unit being, then, the same, it follows that the numbers which express the double densities referred to hydrogen will also represent the molecular weights.

Chemists represent the constitution of molecules by formulae, each of which shows the number of atoms condensed within the molecule. Now, the molecular weights being known, it is very easy to deduce the formulae from them, as these formulae must represent the number of atoms comprised in two volumes.

Such is the relation which exists between the law of volumes and chemical notation. The rule of Avogadro and Ampère has, in fact, become one of the bases of this notation. There are, however, certain exceptions to its generality, but they are probably more apparent than real. Sal-ammoniac, ammonium sulphhydrate, phosphorus, pentachloride, iodine trichloride, sulphuric acid, calomel, amylene hydrobromide, and chloral hydrate have vapor densities such that their molecules appear to occupy four volumes. Such, however, is not the case, and it may be shown that the bodies in question do not volatilize without decomposition, but that when they are heated their molecules split up into two, each of which occupies two volumes. Being unable to analyze all the cases above mentioned, I will confine myself to the last, viz., chloral hydrate, which has given rise to a long discussion.

The question to be decided is, whether this compound is or is not decomposed by conversion into vapor? If it really suffers decomposition, it should be resolved into anhydrous chloral and water. That this decomposition really takes place, may be shown by a method based on the theory of dissociation developed by M. H. Sainte-Claire Deville.

Here is the case in a few words:

We have here in a tube a certain volume of the vapor of chloral hydrate under a certain pressure; it is required to show that this vapor contains vapor of water. For this purpose we are about to introduce into it a body capable of emitting vapor of water; crystallized potassium oxalate, for example. If the atmosphere is dry, this salt will give off vapor of water just as it would in dry air or in vapor of chloroform at the same temperature, and it will continue to emit this vapor until the atmosphere shall have taken up a degree of humidity corresponding with that which is designated by M. H. Sainte-Claire Deville the dissociation tension of the hydrated salt in question. If, on the other hand, the chloral atmosphere is moist, and exhibits exactly the degree of humidity just defined, the crystallized oxalate will not emit any water.

In the first tube, then, we have the vapor of chloral hydrate; the second contains vapor of chloroform. This latter is dry, and I am about to prove to you that the former is moist. In fact, the crystallized potassium oxalate which we are introducing into the chloroform tube will rapidly depress the level of the mercury by emitting vapor of water, whereas in the atmosphere of chloral hydrate it will not emit vapor of water, and consequently will not depress the level of the mercury. This shows that chloral hydrate undergoes decomposition when converted into vapor, and this supposed exception to the rule of Avogadro and Ampère vanishes, like all the rest, when submitted to the test of experiment. This rule appears, then, like a grand law of nature, as simple in its enunciation as it is important in its consequences.

Such are the considerations which I wished to lay before you on the physical and chemical constitution of gases. Does not this exposition seem to show that, of all the states which matter can assume, the gaseous state is the most accessible to our researches, and the best known—not, indeed, that we can affirm the certainty or the theoretical considerations which I have brought before you, for they are but probable. In the physical sciences nothing is certain but well-observed facts and their immediate consequences, and whenever we attempt to make these facts the basis of any general theory, hypothetical data are apt to mix themselves up with our deductions. In the present case the hypothesis consists in assuming that gases, and matter in general, are formed of molecules, and these latter of atoms. No one has ever seen these molecules and atoms, and it is certain that nobody ever will see them. Does it follow, then, that we ought to reject or disclaim this hypothesis? By no means. Our theory may be verified in their consequences, and may thereby acquire a certain degree of probability. The theory under consideration has been subjected to this ordeal, and nothing has hitherto been found to contradict it. It is probable, indeed, that gases are composed of small particles moving freely in space with immense velocities, and capable of communicating their motion by collision or by friction. It is probable that these molecules are diffused in space in numbers so enormous that the most rarefied spaces still contain legions of them, and it is this circumstance which explains the possibility of the movements of the radiometer.

Be this as it may, the idea of Daniel Bernoulli has been developed into a beautiful theory—the kinetic theory of gases—a theory which has shed a sudden clearness, an unexpected light upon matters which seemed to be veiled in the deepest obscurity.

The molecules, as already stated, are invisible. Nevertheless attempts have been made to penetrate this invisible world by the force of scientific reasoning, and by an effort

which does honor to the human mind, even if it be destined to remain barren. The illustrious authors of the kinetic theory of gases have sought to determine, not only the velocities of the gaseous molecules, and the prodigious number of their collisions during a unit of time, but likewise their distances, their absolute dimensions, and their number in a given volume. And here we arrive at results which bewilder the imagination, but which, in this lecture, I must not attempt to unfold.

Permit me only to add that these great labors mark a resting place in our course, and are perhaps an approach toward the solution of the eternal problem of the constitution of matter, a problem which dates from the earliest ages of civilization, and though discussed by all the great thinkers of ancient as well as of modern times, still remains unsolved. May we not hope that in our own time this problem has been more clearly stated and more earnestly attacked, and that the labors of the nineteenth century have advanced the human mind in these arduous paths more than those of a Lucretius, or even of a Descartes and a Newton? From this point of view the discoveries of modern chemistry, so well expressed and summarized by the immortal conception of Dalton, will mark an epoch in the progress of the human mind, and to one of the most important among these discoveries—that of the liquefaction of the gases—grateful posterity will forever join the glorious name of Faraday.—*Nature*.

CHEMICAL SOCIETY, LONDON.*

November 7, 1878.

Dr. J. H. GLADSTONE, F.R.S., President, in the chair.

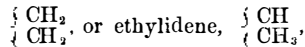
"Contributions from the Laboratory of the University of Tokio, Japan: On the Red Coloring Matter of the Lithospermum Erythrorhizon," by M. Kuhara. The root of the above plant occurs in commerce in thick lumps, purple externally, but yellowish white inside. It was largely used for the manufacture of "Tokio purple," but from the fugitive character of its color and the introduction of aniline dyes its use has been almost abandoned. The root contains about 10 per cent. of glucose and 4 per cent. inverted sugar. The purple coloring matter is extracted almost completely by alcohol, and resembles in some respects anechusin, the coloring matter of alkanet. It is prepared from the root by extraction with alcohol, acidulating the extract with hydrochloric acid, and distilling off the alcohol. The pure coloring matter thus obtained was purified by precipitation with plumbic acetate, etc., in the usual way. It was finally obtained as a dark, resinous, uncrystallizable mass with a metallic green reflection. It is soluble in alcohol, ether, benzol, oil of turpentine, methylic alcohol, and carbon disulphide, but almost insoluble in water. It has a feeble acid reaction and a peculiar odor. It softens at 95° C., and then partially volatilizes in red fumes, which condense on the colder part of the tube. The alcoholic solution has an absorption-spectrum resembling that of alkanet. Stannous chloride decolorizes the solution. It has the formula $C_{20}H_{12}O_{10}$. A barium salt was prepared and decomposed. The paper also contains an account of a bromine and a chlorine compound. Further experiments are in progress.

Dr. Gladstone drew attention to the activity prevailing in the laboratories in Japan, and Dr. Frankland said that the society was much indebted to its fellows in Japan for examining substances which could not be obtained here, and such researches as the above were always very welcome.

The best thanks of the society were then given to the author for his communication.

Dr. Wright then read "A Second Report on some Points in Chemical Dynamics," C. R. A. Wright and A. P. Luff.

Dr. Frankland read a "Note on the Constitution of the Olefine Produced by the Action of Zinc upon Ethylic Iodide," by Dr. Frankland and Mr. Dobbin. This short paper contains an account of experiments made to determine the question whether the gas given off in the above reaction was ethylene—



Many liters, after passing through alcohol and sulphuric acid, were led into a very large bulb-tube containing anti-monic chloride. The contents of the bulb tube were finally mixed with water and distilled. The boiling point as determined by Chapman Jones' method, was 83° C., and was therefore that of ethylenic, and not of ethyldenic chloride, the latter substance boiling at 60°.

In answer to a question of Dr. Armstrong, Dr. Frankland said that although his expectations of obtaining ethyldene were certainly less than before, he should be very sorry to say that it did not exist, and would be still inclined to try further experiments if a reaction could be discovered to eliminate C_2H_4 at a low temperature.

"On the Occurrence of certain Nitrogen Acids among the Products of Combustion of Coal Gas and Hydrogen Flames," by L. T. Wright. The apparatus of the London Gas Referees for determining the sulphur in coal gas was used by the author throughout his experiments. The combustion of 1,000 liters of ammonia free coal gas in a Bunsen burner gave 0.00058 grm. nitrogen as HNO_3 , and 0.00058 as HNO_2 . 1,000 liters of coal gas charged with ammonia gave 0.01071 grm. N as HNO_3 , and 0.00168 grm. N as HNO_2 . The combustion of 1,000 liters of coal gas charged with ammonia, in a normal atmosphere, in a Bunsen burner with air holes closed, gave 0.01595 grm. N as HNO_3 , and 0.00238 grm. N as HNO_2 . The combustion of 1,000 liters of ammonia free coal gas, in an atmosphere charged with ammonia, in a Bunsen burner gave 0.03938 grm. N as HNO_3 , and 0.1115 grm. N as HNO_2 . When hydrogen, passed over strong sulphuric acid, was burned in an ordinary atmosphere, about 0.013 grm. N as HNO_3 , and 0.0002 grm. N as HNO_2 , were produced per 1,000 liters. When the air was thoroughly purified by passing over strong sulphuric acid, etc., no nitric acid and less than 0.00001 grm. N as HNO_2 was obtained. By a still more efficient purification of both hydrogen and air the condensed water was obtained free from nitrates and nitrites. The author, in conclusion, expresses his belief that the origin of the nitrogen acids found in the condensed water procured by burning coal gas or hydrogen in air is ammonia either free or combined.

Dr. Frankland said that the experiments just detailed raised some interesting points as regards the combustion of coal gas. In the combustion of ammonia free coal gas the temperature never rose high enough to cause the oxidation of any large amount of nitrogen. An interesting experiment on the subject was the following:—If a jet of hydrogen be lighted in a glass bell jar no red fumes are

formed, but on adding oxygen to the atmosphere an increase of temperature soon produces perceptible red fumes in the bell jar. In connection with the arc of the electric light, the temperature of which must be enormously high, it would be most important and interesting to determine whether any oxides of nitrogen were formed, and in what quantity.

"On the Action of Bromine upon Sulphur," by J. B. Hannay. In former papers the author showed that when sulphur and bromine were distilled together distillates of any desired composition might be obtained, but that the residue was never free from bromine. The author in the present note attributes this retention of bromine to the sulphur passing into the viscous state, and finds that at 15° complete dissociation can be effected.

"Researches on Dyeing: Part I., Silk and Rosanilin," by Dr. Mills and G. Thomson. The authors have investigated the nature of the transaction which occurs when a vat is exhausted of its tinctorial ingredients. The experiments consisted in immersing a constant area of white silk in a solution of rosanilin acetate, etc., at a constant temperature for varying times, and determining the loss of strength of the rosanilin solution. They have arrived at the following conclusions: (1.) That when silk is dyed with rosanilin salt that salt is deposited as a whole. (2.) That a boiling weak solution of rosanilin salt may undergo dissociation so as to become quite colorless; in which state, however, the dissociating force is wholly overcome by a silk. (Silk is dyed red by immersing it in a solution containing 0.0000003 grm. in 1 c.c., previously rendered colorless by boiling for half an hour.) (3.) That for periods of four days, at the ordinary temperature, a magenta vat is exhausted at compound interest. (4.) That the rate of exhaustion of a magenta vat is retarded by sodic or potassic chloride, and not improbably to an equal extent by equal weights of those chlorides.

"Comparisons of the Actions of Hypochlorites and Hypobromites on some Nitrogen Compounds," by H. J. H. Fenton. Both the above reagents act rapidly on ammonium carbamate, but as with urea, only half the nitrogen is evolved with hypochlorite, while hypobromite causes the evolution of the whole of that gas. The residue from the hypochlorite does not contain nitrogen as a cyanate, but probably in the form of sodium carbamate. Guanidin yields to both reagents two thirds of its nitrogen. The residue behaves like that from the action of hypochlorite on urea. Biuret gives one third of its nitrogen with hypochlorite and two thirds with hypobromite; the residues resemble those from urea. The author's results are given in the following table:

	Urea.	Ammonium Carbamate.	Guanidin.	Biuret.	Ammonia Salts.	Cyanates.
NaClO evolves	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	All	None.
NaBrO	All	All	$\frac{2}{3}$	$\frac{2}{3}$	All	None.

In conclusion the author discusses the formulæ of the above bodies.

"Notes on two New Vegeto-alkaloids," by F. Von Müller and L. Rummel. Alstonin is obtained from the alcoholic extract of the bark of *Alstonia constricta*. It forms an orange-yellow brittle mass, of a bitter taste, melts below 100° C.; is soluble in alcohol, ether, and dilute acids, sparingly soluble in water. Dilute solutions have a strong blue fluorescence, which is unaffected by acids and alkalis. It is precipitated by the usual alkaloid reagents. Duboisin is a volatile alkaloid obtained from the leaves and twigs of *Duboisia myoporoides*, by a process similar to that employed for the extraction of nicotine. Duboisin is probably identical with Staiger's piturin. Duboisin is a yellowish oily liquid, lighter than water, with a strong narcotic odor and alkaline reaction; very soluble in ether, alcohol, and water. It is not precipitated by phospho-molybdate of soda, picric acid, or platonic chloride.

"On the Determination of Lithia by Phosphate of Soda," by C. Rammelsberg. Berzelius detected lithia in Carlsbad water by evaporating the solution of the alkalies with phosphoric acid and sodium carbonate. On treating the whole with water an insoluble phosphate of sodium and lithium remained. This double salt the author has shown to be a variable mixture of the two phosphates. Mayer, however, contradicted these results and denied the existence of a double phosphate, and contended that the above residue was pure lithium phosphate. The author has repeated his former experiments and completely confirmed them, preparing synthetically double salts having sodium to lithium as 1 to 3 or 9 to 2, and therefore the author concludes that lithium cannot be determined by Mayer's method, which is also recommended by Fresenius. The employment of this process for the estimation of lithium in micas has led to too high a percentage of lithium. The author, in conclusion, gives analyses of micas, especially as regards lithium; the lithium and sodium chlorides being separated by treatment with ether alcohol, as suggested some time ago by the author.

HYPOPHOSPHOROUS ACID AND ITS SALTS.

CONCERNING the preparation of the acid the author remarks that only about one-fifteenth of the phosphorus employed is converted into hypophosphorous acid, the bulk passing on to the state of phosphoric acid. He then gives a detailed account of the combinations of hypophosphorous acid with soda, potassa, ammonia, baryta, and lime. He adds that, as there seems to exist only one combination of hypophosphorous acid and lime, it will be possible to titrate neutral solutions of lime with neutral hypophosphite of soda, using reddened tincture of litmus as indicator, since an alkaline reaction must appear when the precipitation is complete. The process may be extended to the salts of lead and other metals.—*Chem. News*.

KINSBOURG and Robert have patented a process in France for obtaining indigo blue from all vegetable matters, whether in a manufactured or unmanufactured state.

"TURKIS" is the name given by C. L. Schultze to a mixture of Nicholson blue and methyl green, dyed on wool in an alkaline bath.

THE iron trade of Sweden is in a very depressed condition, and many workmen are being dismissed.

J. KULTNER, of Nuremberg, has invented a new process for the preparation of ultramarine red and ultramarine violet.

* *Chemical News*.