water of crystallisation, which is present in 100 parts by weight of the solution. C shows the weight of the dissolved substance in the anhydrous condition. The numbers in this column may be calculated from those in the second column by multiplying by the combining weight of the anhydrous and dividing by that of the hydrated substance. Column D gives the weight of the body in the dry state, which is dissolved in 100 parts of water, and is calculated by multiplying the numbers in column C by 100 and dividing by 100—C:—

$$D = \frac{C \times 100}{100 - C}$$

Column E contains the number of atoms of the anhydrous salt in 100 parts by weight of water. The expression *atom* is here synonymous with *equivalent*. The atom of hydrogen is taken at $\frac{1}{100}$:—

$$E = \frac{D \times 100}{A \text{ (anhydrous)}}$$

F gives the volume of the solution; 100 parts by weight of the water of the solution being taken as 100 volumes:—

$$F = \frac{D \times 100}{\text{spec. grav.}}$$

G indicates the specific gravities of the solutions. H contains the volumeter degrees, according to the scale of Guy Lussac, which correspond to the specific gravities:—

$$H = \frac{100}{G}$$

In column I are found the names of the observers, the temperature, and the references to the sources from which the numbers were obtained.

In this first table we find the various numbers corresponding to solutions of different states of concentration. In some cases the numbers are given for solutions at intervals of 1 per cent. of the salt, in others of 5 per cent., and in others of 10. The table commences with caustic alkalies, including ammonia, potash, and soda. Then follow the potassic and sodic carbonates, the chlorides of ammonium, potassium, sodium, lithium, aluminium, magnesium, calcium, strontium, barium, cadmium, and zinc, and stannous and stannic chlorides. The next section contains the bromides of potassium, sodium, lithium, magnesium, calcium, strontium, barium, cadmium, and zinc; whilst under the iodine compounds we find potassic, sodic, lithic, magnesic, calcic, strontic, baric, cadmic, and zincic iodides. Next comes sodic hyposulphate, and the sulphates of ammonium, potassium, sodium, manganese, and iron, the double sulphate of iron and ammonium, magnesic sulphate, potassia-magnesic sulphate, and the sulphates of zinc and copper. This series is followed by sections containing potassic chromate and bichromate, hydric disodic, and trisodic phosphates; hydric disodic, and trisodic arseniates; nitrates of potassium, sodium, magnesium, strontium, barium, and lead; chlorates of potassium and sodium; bromates of potassium and sodium, iodates of potassium and sodium; potassic ferrocyanide and ferricyanide; plumbic acetate; potassic and sodic tartrate; and Rochelle salt. The remainder of the table is devoted to the acids, and includes the following:—Hydrochloric, sulphuric, sulphurous, phosphoric, arsenic, nitric, acetic, tartaric, and citric.

After the table follows a chapter discussing the relations existing between the specific gravities of equally concentrated solutions; and three others: On the change of volume produced by solution of salts; on the change of volume produced on the dilution of aqueous solutions; and on the change of volume produced by mixing different solutions.

The pamphlet concludes with a table extending over 19 pages, and containing the specific gravities of solutions, in most cases from 1 per cent. to nearly the point of saturation, though in some few instances they are given at every 5 per cent. This table gives, in addition to those of the substances above enumerated, the specific gravities of solutions of sugar and alcohol. Dr. Gerlach deserves the thanks of chemists and chemical manufacturers for undertaking the tedious labour of collecting and arranging in tables the large series of numbers which are found in this pamphlet.

SCIENTIFIC SERIALS

THE *American Journal of Science* for May, 1870, contains a good article "On a simple method of Avoiding Observations of Temperature and Pressure in Gas Analyses," by Wolcott Gibbs, M.D., Professor in Harvard University.

In absolute determinations of nitrogen and other gases, accurate observations of temperature and pressure are, in the ordinary methods of analysis, necessary, and when made require subsequent calculations which, when the analyses are numerous, become rather tedious. By the following simple method these observations may be altogether dispensed with, and the true weight or the reduced volume of the observed gas, obtained at once by a single arithmetical operation.

"A graduated tube, holding about 150 cubic centimetres, is filled with mercury, and inverted into a mercury trough. Two thirds or three fourths of the mercury are then displaced by air, care being taken to allow the walls of the tube to be slightly moist, so as to saturate the air. This tube may be called the companion tube; the volume of air which it contains must be carefully determined in the usual manner by five or six separate observations, taking into account, of course, all the circumstances of temperature and pressure. The mean of the reduced volumes is then to be found, and forms a constant quantity. The gas to be measured is transferred from the receiver in which it is collected, into a (moist) eudiometer tube, which is then suspended by the side of the companion tube, and in the same trough or cistern. Both tubes being supported by cords passing over pulleys, it is easy to bring the level of the mercury in the two tubes to an exact coincidence. The pressure on the gas is then the same in each tube. The temperature is also the same, as the tubes hang side by side in the room set apart for gas analyses, and are equally affected by any thermometric change. It is then only necessary to read off the volumes of the gas in the two tubes to have all the data necessary for calculating the weight of the gas to be measured. . . . . As the observed volume of the air in the companion tube is to the observed volume of the gas in the measuring tube, so is the reduced volume of the air in the first—previously determined as above—to the reduced volume of the gas to be measured. This method of course applies to the reduction of any gaseous mixture whatever to the normal pressure and temperature. . . . . In practice, a companion tube filled with mercury will last with a little care for a very long time. Even when filled with water I have found that excellent results may be obtained, and that the tube will last for some weeks. Williamson and Russell, in their processes for gas analysis, have employed a companion tube for bringing a gas to be measured to a constant pressure, but the application made above is, I believe, wholly new."

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 19.—"A Ninth Memoir on Quantics." By Prof. Cayley.

It was shown not long ago by Prof. Gordan that the number of the irreducible covariants of a binary quantic of any order is finite (see his memoir "Beweis das jede Covariante und Invariante einer binären Form eine ganze Function mit numerischen Coefficienten einer endlichen Anzahl solcher Formen ist," Crelle, t. 69 (1869), memoir dated 8th June 1868), and in particular that for a binary quantic the number of irreducible covariants (including the quantic and the invariants) is = 23, and that for a binary sextic the number is = 26. From the theory given in my "Second Memoir on Quantics," *Phil. Trans.* 1856, I derived the conclusion, which as it now appears was erroneous, that for a binary quintic the number of irreducible covariants was infinite. The theory requires, in fact, a modification, by reason that certain linear relations, which I had assumed to be independent, are really not independent, but, on the contrary, linearly connected together: the interconnection in question does not occur in regard to the quadric, cubic, or quartic; and for these cases respectively the theory is true as it stands; for the quintic the interconnection first presents itself in regard to the degree 8 in the coefficients, and order 14 in the variables; viz., the theory gives correctly the number of covariants of any degree not exceeding 7, and also those of the degree 8, and order less than 14; but for the order 14 the theory as it stands gives a non-existent irreducible covariant