

as it ascends through the bark, into a solid cylindrical bundle, in which, in time, a medulla forms as before. The author is inclined to believe that all these latter forms of bundles only supply short abortive lateral branches, which most probably supported *Lepidostrobous* fruits.

II. "A Method of examining Rate of Chemical Change in Aqueous Solutions." By G. GORE, F.R.S. Received January 11, 1889.

(Abstract.)

This research supplies an outline of a method of examining chemical change, based upon the application of the "voltaic balance" to measuring the relative amounts of voltaic energy of electrolytes (see 'Roy. Soc. Proc.,' vol. 44, pp. 151, 294), and the rate of chemical change is indicated by alterations in amount of such energy.

The author gives an example of two liquids, viz., a solution of equivalent proportions of potassic iodide and chlorine, and one of chloride of potassium and iodine, which, although having the same ultimate chemical composition, are greatly different (viz., as 1.0 to 31.76) in voltaic energy, and in a moderate degree different in colour. The latter of these is a nearly stable liquid, and does not readily alter in chemical composition at 13° C., whilst the former is extremely unstable, continually losing voltaic energy, and becoming darker in colour at that temperature, until it nearly acquires the chemical composition and properties of the other mixture.

From the results obtained it is concluded—1st, that the aqueous solution of equivalent proportions of potassic iodide and chlorine decomposes spontaneously at 12° C., with gradual formation of potassic chloride and liberation of iodine; 2nd, that the change of chemical composition is attended by considerable loss of voltaic energy; 3rd, that more than six days are necessary to effect the complete chemical change at that temperature; and, 4th, that the rate of chemical change is much greater at the commencement of the action than towards its termination. Further, that the solution of potassic chloride and iodine increases slightly in energy during the mixing.

The influence of dilution, time, temperature, light, agitation, and mode of mixing upon the chemical change was examined. It was found that the degree of dilution of the constituent liquids of the potassic iodide and chlorine solution *during the act of mixing* largely affected the amount of chemical change which occurred during mixture, but with the solution of potassic chloride and iodine the strength of the liquids had no such effect. The effect of dilution appears to be

related to the degree of mobility and diffusibility of the particles, and is largely modified by the degree of stability of the mixture.

Temperature had great effect upon the solution of potassic iodide and chlorine. Heating the liquid to about 100° C. during two minutes was attended by great loss of voltaic energy, considerable increase of colour, and about 99.8 per cent. of the mixture was changed into potassic chloride and free iodine; the amount of change was as great as that which took place during 18 days at 12° C. Similarly heating the solution of potassic chloride and iodine had but little effect; it, however, slightly increased its voltaic energy and decreased its colour, and so far changed it into the other mixture (?).

Exposing the solution of potassic iodide and chlorine to diffused daylight during 18 dull winter days at about 12° C. did not appear to greatly alter the rate of chemical change, as shown by alterations of colour and of voltaic energy. Light somewhat retarded the action.

Strong agitation during one minute of the freshly made solution appeared to slightly increase the amount of chemical change which occurred during mixture.

In making this solution the amount of chemical change which took place during mixing was about 5 per cent. more if the chlorine solution was added to the solution of iodide than if the order of addition was reversed.

The results of the experiments show that the solution of potassic iodide and chlorine was very unstable, highly sensitive to rise of temperature, had a great tendency to lose its voltaic energy, to change its chemical composition, and approach that of the other mixture; that the solution of the latter was very much more stable, and much less sensitive to heat, but had a feeble tendency to absorb energy, to change its chemical composition, and approach that of the solution of potassic iodide and chlorine. The effect, therefore, of heating both liquids was to produce two portions possessing similar chemical composition and properties, but much more nearly resembling the chloride than the iodide mixture, and consisting of about 0.23 part of potassic iodide, 74.49 of potassic chloride, 126.8 of iodine, and 0.0497 of chlorine.

The collective results show that the "voltaic balance" method may be used to detect changes of chemical composition of aqueous solutions, and to measure the rate of such change going on in them. Although the method as described does not give the amount of change which occurs during the mixing of the liquids, it gives the subsequent amounts of change with a reasonable degree of accuracy. Its great advantage over the colorimetric method is that it is equally applicable to colourless liquids; it is much more sensitive and exact than either the colorimetric or the thermochemical method; and it is quick and easy of performance. It is at present being used to detect and measure

chemical changes produced by light in aqueous solutions. The degree of freedom of an aqueous solution of chlorine from hydrochloric acid and of iodine from hydriodic acid was determined much more readily by means of the "voltaic balance" method than by ordinary chemical analysis.

III. "Relative Amounts of Voltaic Energy of dissolved Chemical Compounds." By G. GORE, F.R.S. Received January 16, 1889.

(Abstract.)

In this investigation the author has measured, by means of the "voltaic balance," the amounts of relative voltaic energy or of chemical affinity for zinc, of nearly 250 aqueous solutions of dissolved chemical compounds, at ordinary atmospheric temperatures. The substances include compounds of elements with elements; elements with monobasic, bibasic, and tribasic acids; acids of all these classes with each other; elements with monobasic, bibasic, tribasic, and tetrabasic salts; monobasic, bibasic, and tribasic acids with all these classes of salts; and all these classes of salts with each other in great variety. The method employed has been already described (see 'Roy. Soc. Proc.,' vol. 44, pp. 181, 294), and he offers the results thus obtained as additional evidence in support of the conclusion, that "*every electrolytic substance or mixture when dissolved in water unites chemically in definite proportions by weight with every other such dissolved body, provided no separation of substance occurs;*" and that "there may probably be discovered thousands of such compounds, which only exist whilst in aqueous solution, and are decomposed on evaporating or crystallising their solutions." The present research has shown the existence of nearly 250.

The formulæ of the compounds, together with the amounts of energy, are arranged in the form of a table as a volta tension series of electrolytes, commencing with $I + Cl$, which gives a plus number of +11,686,507, and ending with $2(H_3N + KHO) + (K_2CO_3 + Na_2SO_3)$, which gives a minus one of -959,817. The whole of the formulæ agree with the ordinary chemical equivalents of the substances.