

crust, and are accompanied by magnetic currents which serve as indices of their approach.

Prof. E. W. Morley's report on the velocity of light in a magnetic field shows an increase in velocity in such a field amounting to seven parts in one thousand million. These investigations are to be continued.

Prof. Morley also read a paper on the determination of the volumetric composition of water, and one on the ratio of the density of oxygen and hydrogen. In twenty determinations the minimum value of combination in water was 2'0005, the maximum was 2'00047, mean 2'00023, with a probable error of one part in 30,000. The value two to one, which every schoolboy learned is the ratio of hydrogen and oxygen in water, must be increased about one nine-thousandth. In two determinations of density, Morley reaches the same result as Rayleigh, viz. 15,884, giving 15,882 as the atomic weight of oxygen. Prof. W. A. Noyes read a paper on the atomic weight of oxygen, giving the results of four series of six determinations with apparatus devised by himself. The value found is 15,896, or about seven one-hundredths less than the usually accepted one.

The series of papers on distribution of North American plants, prepared on topics assigned last year, was pronounced by the presiding officer the most remarkable ever presented to the biological section. They were on the distribution of the North American umbelliferae, by John M. Coulter; the distribution of hepaticæ of North America, by Lucien M. Underwood; geographical distribution of North American grasses, by W. J. Beal; geographical distribution of North American cornaceæ, by John M. Coulter; and the general distribution of North American plants, by N. L. Bulton. The following assignments were made for next year:—The absorption of gases, J. C. Arthur; the aëration of aquatic plants, W. P. Wilson; the absorption of fluids, L. H. Pammel; the movement of fluids in plants, W. J. Beal; transpiration, C. E. Bessey.

The exhibition of apparatus included some delicate seismoscopes and seismometers. Prof. Mendenhall exhibited some of the metric standards recently distributed by the International Congress, in the manufacture of which to distribute to all nations, two-thirds of all the iridium in the world was used. Prof. W. A. Rogers exhibited a precision screw 8 feet long, with a variation of only 1/8000 of an inch in its entire length.

Officers elected for the Washington meeting were: President, Albert B. Prescott, of Ann Arbor, Mich.; Vice-presidents, Section A, E. W. Hyde, of Cincinnati, O.; Section B, F. E. Nipher, St. Louis, Mo.; Section C, R. C. Kedzie, Agricultural College, Mich.; Section D, Thomas Gray, Oene Haute, Ind.; Section E, J. J. Stevenson, New York; Section F, J. M. Coulter, Crawfordville, Ind.; Section H, Joseph Jastrow, Madison, Wis.; Section I, Edmund J. James, Philadelphia, Pa.; Permanent Secretary, F. W. Putnam, Cambridge, Mass. (holds over); General Secretary, Harvey W. Wiley, Washington, D.C.; Secretary of the Council, Amos W. Butler, Brookville, Ind.; Treasurer, William Lilly, Manch Chunk. Secretaries of the sections: Section A, E. D. Preston, Washington, D.C.; Section B, A. McFarlane, Austin, Texas; Section C, T. H. Norton, Cincinnati, O.; Section D, William Kent, New York; Section E, W. J. McGee, Washington, D.C.; Section F, A. J. Cook, Agricultural College, Mich.; Section H, W. H. Holmes, Washington, D.C.; Section I, B. E. Vernon, Washington, D.C.

This ticket was elected as reported from the nominating committee, except that a substitution was made in the Vice-President for Section I, which is notable as the first instance in the history of the Association in which any change was ever made in the list of nominees reported.

WM. H. HALE.

CHEMISTRY AT THE BRITISH ASSOCIATION

MANY of the papers read in Section B this year were of considerable theoretical importance. Additional interest was also given to the proceedings by the presence of several distinguished foreign guests.

After the President's Address, Prof. Dunstan read the third Report of the Committee on the present methods of teaching chemistry. During the past year the Committee has been principally engaged in collecting and comparing the regulations issued by the more important of the examining bodies in the kingdom, in order to discover how far their requirements were in harmony with such a course of instruction as that suggested

by the Committee in their second Report, presented at the Newcastle-on-Tyne meeting. The Committee direct special attention to the following points:—

It is of great importance that natural science should be sufficiently represented on the board which issues the regulations and is responsible for the proper conduct of the examination.

In addition to examinations, periodical inspection of the teaching seems desirable, the reports of the inspectors as well as the students' own record of work testified to by the teacher being taken into account in awarding prizes, certificates and grants, in addition to the results of an examination.

With respect to the schedules and examination papers, for the most part they do not aim at an educational training of the kind suggested in the Committee's last report, being on the other hand more suitable for those who wish to make a special and detailed study of chemistry as a science. The obvious conclusion is that the necessary reforms can only be brought about by the active co-operation of examiners and teachers.

Sir Henry Roscoe introduced a discussion on recent legislation for facilitating the teaching of science. He drew attention to the powers given by the Technical Instruction Act of 1889, to County Councils and other local authorities, and assured his hearers that the Education Department and the Science and Art Department were extremely anxious to give local authorities a free scope, and free choice of subjects. Referring to the action of the Chancellor of the Exchequer, which placed in the hands of the County Councils this year the sum of £743,000 to be devoted, whole or in part, to the purpose of technical education, he urged upon these bodies the importance of taking full advantage of this grant. In the discussion which followed hopes were expressed that the money would not go simply towards the relief of the rates. It was also remarked that for the success of these provisions it is necessary that more attention should be given to primary education.

Dr. J. H. Gladstone and G. Gladstone read a paper on the refraction and dispersion of fluorobenzene and allied compounds. Fluorine behaves quite differently to chlorine, bromine, and iodine, as it exerts scarcely any refractive action upon the light rays, and it has the property of reversing the dispersion produced by other substances.

Dr. G. H. Bailey and J. C. Cain gave a paper on a method of quantitative analysis by weighing precipitates suspended in liquids. The object of the method is to do away with the operations of filtering and washing. The specific gravity of the precipitate having been determined once for all, it is weighed together with the supernatant liquid in a specially constructed measuring flask. The specific gravity of the supernatant liquid can be readily determined, and hence the weight of the precipitate calculated. The method is found to be rapid, and to give results of sufficient accuracy for many technical purposes.

Dr. G. H. Bailey and A. A. Read gave a paper on the behaviour of different metallic oxides when exposed to high temperatures. This is a continuation of work previously published in the Journ. Chem. Soc. on oxide of copper. The following oxides were subjected to high temperatures in an oxidizing atmosphere:—SnO₂, Bi₂O₃, V₂O₅, PbO, WO₃, MoO₃. The following results were obtained:—V₂O₅ was converted into V₂O₃, SnO₂ lost weight slightly, and MoO₃ lost oxygen, and was transformed into the blue oxide of molybdenum, the others were unchanged. It was suggested that some light might be thrown by the experiments on the formation of minerals in nature.

A paper was then read by Dr. G. H. Bailey on the spectrum of the haloid salts of didymium. The influence of dilution and of various reagents on the intensity of the different bands was studied. It was found that the addition of nitric acid to the solution of didymium chloride influenced some bands quite differently to others. Again the variation of the halogen element, in combination with the didymium, brought about differences in the relative positions of the bands. In addition to these, observations were also made on the effect of polarised light. Each of these different conditions influenced the bands sometimes in intensity, sometimes in position, and this in a selective manner. The connection was pointed out between these results and the experiments of Welsbach on the fractionation of didymium.

Prof. Armstrong read the fifth Report of the Committee on isomeric naphthalene derivatives. A complete set of reference compounds has now been prepared in the disubstituted series. It is found that although 13 dichlor naphthalenes have been

described only 10 exist. Of the 14 possible triderivatives 13 are known. Light has been thrown by these researches on the mode of action of reagents upon naphthalene and other hydrocarbons, and it appears that in all cases the initial action is the same, the ultimate product depending on secondary causes, *e.g.*, in the case of benzene an ortho compound is always first obtained, meta and para compounds being produced by secondary causes. The influence of structure on the colouring properties of naphthalene derivatives has also been studied in connection with these researches.

Prof. J. H. Van't Hoff read a paper on the behaviour of copper potassium chloride and its aqueous solutions at different temperatures.

This compound, which is a blue salt, splits up on heating into potassium chloride, water, and a brown double salt, according to the following equation: $\text{CuCl}_2 \cdot 2\text{KCl}_2 \cdot \text{H}_2\text{O} = \text{CuCl}_2 \cdot \text{KCl} + \text{KCl} + 2\text{H}_2\text{O}$. On cooling the reverse change takes place. The brown salt can also be formed by the action of cupric chloride on the blue salt thus: $\text{CuCl}_2 \cdot 2\text{KCl} \cdot 2\text{H}_2\text{O} + \text{CuCl}_2 \cdot 2\text{H}_2\text{O} = 2\text{CuCl}_2 \cdot \text{KCl} + 4\text{H}_2\text{O}$. The changes of volume attending these transformations have been studied, also the solubility of the various constituents of the system at different temperatures, and the vapour pressure of their solutions, and interesting relations are shown to exist between the values obtained in each case.

Dr. Richardson read the Report of the Committee for the investigation of the action of light on the hydracids of the halogens in presence of oxygen.

It has been found that the presence of 10 per cent. hydrochloric acid prevents all decomposition of chlorine water, even after long exposure to sunshine.

Aqueous solutions of pure bromine and iodine have been exposed to sunlight for a period of fourteen months. It was found that, in a dilute solution of bromine water (0.16 per cent. Br.), as much as 57 per cent. of the total bromine is converted into hydrogen bromide; in a saturated solution the minimum amount of decomposition occurs, again increasing with further additions of bromine. With iodine water under an atmosphere of carbon dioxide, 8.3 per cent. of the total iodine in the solution was converted into hydrogen iodide. Under an atmosphere of air 14.2 per cent. of the total iodine was converted. Further experiments have been made on the oxidation of gaseous hydrogen bromide in sunlight. The presence of free bromine exercises a retarding influence on the decomposition.

The influence of temperature on the oxidation of hydrogen chloride and bromide has been studied. Rise of temperature appears to retard oxidation in the first case and accelerate it in the second.

Profs. Liveing and Dewar gave a paper on some experiments on the explosion of gases under high pressure. It was found that with increase of pressure the luminosity of the flame steadily increased. When hydrogen was exploded with excess of oxygen, it was found that large quantities of nitrogen peroxide were formed from the nitrogen present as impurity in the oxygen. The water formed contained 3 per cent. of nitric acid. With excess of hydrogen small quantities of ammonia were formed. It was found that, in an atmosphere of carbon dioxide, it was very difficult to maintain the oxy-hydrogen flame if the pressure exceeded two atmospheres. Experiments were also made with ethylene and cyanogen exploded with oxygen.

Prof. H. B. Dixon and J. A. Harker gave a paper on the rates of explosion of hydrogen and chlorine in the dry and wet states. They showed that there was no great difference in the rate, such as they had previously found with carbonic oxide and oxygen mixtures, thus showing that, in the case of hydrogen and chlorine, the aqueous vapour simply acts like any other inert gas, making the rate a little slower.

Dr. G. S. Turpin read a paper on the ignition of explosive gaseous mixtures. The author has commenced a thorough investigation of the conditions affecting the ignition of explosive mixtures of gases, and the present paper gives an account of the results obtained in a series of experiments on the temperatures of ignition of various mixtures of CS_2 vapour with oxygen and other gases. The method used is a modification of Mallard and Chatelier's second method, in which the gases are introduced into a heated and exhausted bulb. The existence of a discontinuity between gradual combustion and ignition proper is found to exist in some cases, while in others there is a perfect gradation from slow combination, attended by a faint glow, to instantaneous combination, attended by a bright flame. The effect of change of pressure on the ignition was examined and found to be somewhat complex.

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The Report of the Committee on the properties of solutions was read by Dr. Nicol. The experiments have now been completed on the solubility of a salt in a solution of another salt, of known strength. In general a salt is less soluble in a salt solution than in pure water. An exception is the case of the solubility of KNO_3 in solution of NaNO_3 .

A joint discussion with Section A on the nature of solution and its connection with osmotic pressure was opened by Prof. Pickering, in a paper on the present position of the hydrate theory of solution. The supporters of the hydrate theory claim that the curved figures, representing the properties of solutions of various strengths, show sudden changes of curvature at certain points, which are the same whatever be the property examined, which correspond to the composition of definite hydrates, and which, therefore, can only be explained by the presence of these hydrates in the solutions; while the supporters of the physical theory, now identified with the supporters of the osmotic pressure theory, claim to have shown that, with weak solutions at any rate, the dissolved substance obeys all the laws which are applicable to gases, and that, therefore, its molecules must be uninfluenced by, and uncombined with, those of the solvent.

With regard to the lowering of the freezing-point of a solvent, the following questions were proposed:—

- (1) Is the molecular depression (*i.e.* that produced as calculated for one molecule dissolved in 100 molecules) constant, independent of the nature of the solvent?
- (2) Is it independent of the strength of the solution, so long as this strength does not exceed the limits (gas strength) above mentioned? (Boyle's law).
- (3) Is it independent of the nature of the dissolved substance? (Avogadro's law).

Evidence was adduced involving a negative answer to each of these questions.

Objection was taken to the theory of dissociation into ions, on the grounds of its irreconcilability with our ideas of the relative stability of various bodies, and with the principle of conservation of energy.

A letter was afterwards read from Prof. Arrhenius in which it was shown that both the osmotic pressure and the electrical dissociation theories must be taken into account in drawing conclusions from observed numbers.

Prof. Armstrong remarked that, according to the electrical dissociation theory, hydrochloric acid and water must be regarded as entirely different substances, whereas in their chemical relations they are very nearly allied.

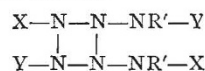
Prof. Fitzgerald, Prof. Ostwald, and Prof. Lodge all spoke to the effect that Ostwald's experiment, on the decomposing effect of a charged body on a salt solution, does not involve a contradiction of the principle of the conservation of energy.

P. J. Hartog and J. A. Harker described a convenient form of apparatus for determining freezing-points, and for performing reactions in the cold. Adopting a proposal of Raoult, the evaporation of a volatile liquid is used to produce low temperatures.

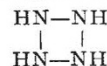
A paper was given by A. G. Green, C. F. Cross, and E. J. Bevan, on a method of photographic dyeing and printing. It was observed that the diazo-compound of primuline was decomposed by light, thereby losing its property of combining with phenols and amines. If a material, dyed with diazotized primuline, be exposed to light under a design, those parts which are acted upon by light will be decomposed, whilst the parts protected from the light will remain unaltered, and consequently on subsequent development with a phenol or amine, will produce colours, whilst the decomposed portions will not.

Prof. Thorpe gave a demonstration of some of the most striking properties of phosphorous oxide. He believes that the physiological effects usually ascribed to phosphorus are due in reality to this oxide.

Prof. R. Meldola read a paper on diazo-amido-compounds, a study in chemical isomerism. The paper dealt largely with heterogeneous diazo-amides, which the author believes have the general constitutional formula—

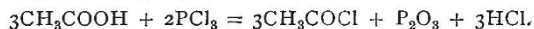


thus being derivatives of a hypothetical tetraimine—



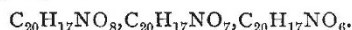
Compounds have been prepared of all degrees of stability, from well-defined individuals to molecular compounds. The above general formula has been given for chemical reasons. A molecular weight corresponding to half that represented by the above formula is given by Raoult's method, but it is believed that dissociation takes place in solution.

C. H. Bothamley read a paper on the action of phosphorus trichloride on organic acids and on water. The equation given in the text-books, representing the action of phosphorus trichloride on organic acids, is shown to be incorrect. An equation given previously by Thorpe is confirmed, viz. :—

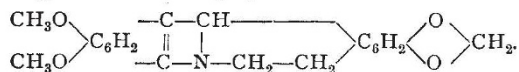


The reaction, however, only takes place according to this equation in the case of acids of low molecular weight, and when the reacting substances are present in the required proportions. As the molecular weight of the acid increases the reaction tends to become more complex.

A paper was read by Prof. W. H. Perkin, Jun., on the constitution of the alkaloid berberin. On treatment with permanganate the alkaloid yields three principal oxidation products of the following empirical formulæ :—



From the results of the careful investigation of these, the following formula has been proposed for berberin :—



In the course of the meeting interesting discourses were given by Dr. W. H. Perkin on the development of the coal-tar colour industry since 1880, and by Prof. Hummel on fast and fugitive coal-tar colours.

GEOLOGY AT THE BRITISH ASSOCIATION.

THE short but extremely useful address of the President, A.

H. Green, Professor of Geology at Oxford, formerly of Mathematics and Geology at the Yorkshire College, dealt with the educational aspect of Geology. Although he dwelt on the risk of becoming loose reasoners, which geologists continually ran, the President pointed out how by a proper training in minute and delicate experimental work, the student might be taught the necessity of exactness, and could then proceed to practical work, which would lead him into the open air, and compel him to acquire the eye and enthusiasm necessary for geological research.

Amongst the reports presented to the section was one by Prof. T. R. Jones, describing a *Saccocaris* from the Arenig, *Aristozoa* and *Esteria* from the Devonian and Carboniferous; one by Mr. G. R. Vine, giving lists of Cretaceous Polyzoa from the Neocomian, Gault, Upper Greensand, Cambridge Greensand, and Red Chalk; one from Mr. A. Bell giving the lists of fossils obtained from the "manure gravels" of Wexford, by which he is able to indicate the date of the final separation of Ireland from England; and one from Mr. Marr, giving the proposed circular letter and record sheet to be issued to the curators of public and private museums, in order to obtain a reliable register of the location of all type specimens of fossils.

Mr. Jeffs presented the report of the Photograph Committee containing a list of about 300 photographs of geological interest, and suggestions for their collection and registration; he also exhibited photographs collected during the present year, amongst which some from Yorkshire, Antrim, and Scotland were of especial value; Dr. H. Johnston-Lavis gave an elaborate report on the volcanic phenomena of Vesuvius, including a plan of the cone in April 1890, an estimate of the lava extruded between May and December, 1889, and a general record of the doings of the volcano in the year; while Mr. De Rance's report on underground water included an immense number of well sections in different parts of England.

The chief papers contributed to the section were perhaps those on local geology, some of which gave the results of many years' research. Mr. Holgate described the coals and clays of Leeds, and showed that the colour and texture of the containing rock was influenced by the nature of its fossils; thus, the more delicate plants like ferns give blue, larger plants black, and

animal remains hard, black rocks. He followed with a paper on the physical properties of coals, in which he showed that coals with a dull black colour and a wide cleat were chiefly made of spores, with but little fusible ash, and were the best for use where the temperature is high; while the bright, soft coals, with close cleavage, made largely of mineral charcoal and probably of plant stems, contained much fusible ash, broke up in burning and formed slow burning, caking coals. Mr. J. R. Dakyns described the setting in of the Yoredale beds in Yorkshire, and the gradual changes which occur in them and in the lower and upper Millstone grit as the beds are traced northwards; Messrs. Cash and Lomax accentuated the identity of *Lepidophlois* and *Lepidodendron*, of which plants a magnificent series of slices was displayed in the temporary museum; Mr. J. W. Davis stated that fish remains had been found at nine horizons in the West Riding coal-field, from two of which, one above the Better bed and the other in the Adwalton Cannel of Tingley, no less than sixty species of fish and some of Labyrinthodonts had been described. Mr. Tate identified the so-called "Ingleton Granite" as a quartzose volcanic tuff, and Phillips's dyke at Ingleton as a mica-trap belonging to the minette group; Dr. Hatch also described mica-trap dykes from nine localities in West Yorkshire. Prof. Silvanus Thompson gave the results of experiments on the sources of the river Aire made by means of the fluorescent properties of uranin, and Mr. Maule Cole described a lacustrine deposit of post-glacial age near Filey.

Mr. Lamplugh dealt with the famous cliff section at Speeton, which was in capital condition for the inspection of a geological excursion on Saturday. He divided it into five zones by its belemnites, and by means of this classification was able to correlate its divisions with those of Lincolnshire. The same author gave a table of the Yorkshire boulders, from which he concluded that the North Sea ice stream drove that from the valleys of the Tees and other northern rivers southward and pressed it against the high eastern coast of Yorkshire. In a second paper he argued that the North Sea ice which formed the Basement Clay with its shelly inclusions, overtopped the Speeton cliffs and overrode Flamborough Head, passing into Bridlington Bay; the purple clays of Holderness were the equivalent of gravels of the interior and to the north; whilst the Upper Boulder Clay (and Hessele Clay) was formed by the retirement of extra-British ice and the increase of that from the Pennine high land. Mr. Lamplugh also presented a final list of mammals and shells from the ancient sea beach of Bridlington, which is earlier in date than the first glaciation of the Yorkshire coast. In connection with local glacial work may be mentioned Dr. Crosskey's report on erratic blocks; he exhibited a fine map of the distribution of the principal boulders in the Midlands, gave lists of boulders from Warwickshire, Lancashire, Cheshire, Isle of Man, and Yorkshire, and attributed their deposit to at least two distinct periods; Mr. Kendall's note on the occurrence of Eskdale and Scotch granites and local rocks in the glacial drifts of the Isle of Man; the account of the boulders of Scotch and Cambrian granites and other rocks from the Cheshire area by Messrs. Antrobus and Hatch; and a paper by Mr. E. Jones describing the find of neolithic burials in the Elbolton cave near Skipton.

Taking the more general papers in order, we come to two papers by Dr. Hicks, one on earth-movements and their effects on Archæan and Lower Palæozoic rocks in Wales and Shropshire, and a second on the contents of Cambrian conglomerates, which provoked some discussion. In the latter he identifies twenty types of fragments, many of which must have been derived from Archæan rocks, while in the former he attributes many phenomena to earth-movement, which have often been put down to intrusion. Mr. Morgan noted the occurrence of Llandovery rocks in Montgomeryshire, and Mr. Watts correlated so far as possible the Silurian rocks of the Long Mountain with those of the typical Silurian areas of Wenlock and Ludlow. An important paper, establishing correlations in the Devonian rocks of South Devon and Cornwall, was read by Mr. Ussher, and one on an unconformity involving the absence of two zones in the Upper Lias of Bridport, by Mr. J. F. Walker. Mr. Whitaker suggested that trials for coal in the south-east of England might well be made in such localities as St. Margaret's, Chartham, Chatham, Bushey, and Coombs, where borings had already given some idea of the thickness and character of the secondary rocks. Mr. G. H. Morton showed that the Liverpool Bunter was 1950 feet in thickness and the Keuper, of which only the lower part is exposed, 800 feet; two important pebble beds