

times used for  $\text{CO}_2$ , sometimes for  $\text{CO}$ . In Table II, the prominence of this "diversity of names for the one thing," and giving the same name to distinct substances, is more frequent. The use of numerical prefixes has also been very irregular; "thus, trisodic phosphate has been called 'triphosphate of soda,' 'diphosphate of soda,' and 'sesquiphosphate of soda'; in all these cases the prefix is intended to indicate the number of molecules of soda to one molecule of phosphoric acid." "In some of the older forms of nomenclature ambiguity was avoided by using the prefix 'bi-' to multiply the acid when in excess over the base, and 'di-' to multiply the base when in excess over the acid; thus,  $\text{Na}_2\text{O}_2\text{SiO}_2$ , bisilicate of soda,  $2\text{Na}_2\text{OSiO}_2$ , disilicate of soda." The Report goes on to say that "the usefulness of any system of nomenclature depends on its permanence." Curiously enough the tables show that where names have been adopted supposed to represent in some way the chemical constitution of bodies, they have not, as a rule, endured; the advance of knowledge necessitating a change of opinion, whilst names not expressing a chemical opinion as to constitution have endured. "As a rule, those names are to be preferred which have shown most vitality and have led to no ambiguity. Where there are two compounds composed of the same elements, the termination, 'ous' and 'ic' should be employed. The prefixes 'proto' and 'deuto,' introduced by Thomas Thomson, were intended to mark the compounds in a series, not the number of atoms in a molecule. Where retained this use only should be made of them." Referring to change of name, instance is made of the oxides of carbon, the names of which have recently to some extent been transposed, the higher one being termed "carbonic oxide," and the lower one, to which the term "carbonic oxide" has long been applied, has had a new name. The sensible conclusion of the Report is to retain names of substances which are in common use, rather than to change them for names indicating constitution, and which might be again found to require alteration in accordance with some new view of the constitution of the substance.

#### SECTION B—CHEMISTRY

At the meeting of the Chemical Section at Montreal a new departure was made in the selection by the Organising Committee of two subjects for special discussion. The subjects chosen were: "The Constitution of the Elements," and "Chemical Changes in their Relation to Micro-Organisms."

##### *Discussion on "The Constitution of the Elements"*

Prof. Dewar began by referring to Grove's discovery that water suffered decomposition at the temperature of the oxy-hydrogen flame, an experiment which led Sainte-Claire Deville to undertake his researches on dissociation. Deville has shown that in compound substances there is an equilibrium between decomposition and recombination, this balanced relation changing with the temperature. The experiments of Deville on the temperature of burning gases agree closely with the results obtained by Bunsen, who determined the pressures generated in the explosion of hydrogen and other gases with oxygen. The breaking up of the iodine molecule, effected by Victor Meyer, is a decomposition of elementary matter. Owing to the rapid recombination, there seems no hope of isolating atomic iodine at low temperatures. The vapours of potassium and sodium have different densities at different temperatures; probably also their molecules consist of two atoms at lower, and of one atom at higher, temperatures. More exact determinations are needed of those substances which exhibit a variable vapour density. The evidence afforded by spectral analysis proves that oxygen and nitrogen have two spectra, and therefore probably different molecules at different temperatures. Hydrogen has a complicated spectrum under certain conditions. Referring to Mr. Lockyer's speculations, he said there was a general basis of similarity in the type of the vibrations of certain allied elements, viz. the triple lines in zinc and cadmium. Mr. Lockyer has proved that the identity of certain "basic" lines of different elements, such as iron and calcium, is not due to impurity, but the greater dispersion of more powerful instruments has shown that the coincidence of these lines is only apparent and not absolute. The differences observed in some of the spectral lines of a single element in the sun might be accounted for not by the decomposition of the "element" into simpler matter but by great differences of level in the luminous vapour. Prout's hypothesis, that the atomic weights of the other elements are

multiples of that of hydrogen, has no basis in experimental fact. Stas and Marignac have both returned in their old age to the redetermination of the atomic weights made by them twenty years ago. Stas, avoiding the possible sources of error in his former methods, has lately found 14.055 for the atomic weight of nitrogen; his old determinations gave 14.044. For potassium he now arrives at the number 39.142 instead of 39.137. Marignac gives the following as the atomic weights of zinc and magnesium, 65.33 and 24.37,—numbers very far removed from whole numbers.

Prof. Wolcott Gibbs drew the attention of the Section to the probability that what is generally regarded as a simple molecule, such as sodium chloride, consists in the solid state of several hundreds of atoms, and that the salt undergoes in solution a kind of molecular dissociation. Very complex molecules, such as those acids he had prepared containing many molecules of the oxides of molybdenum, vanadium, barium, &c., are probably derived by substitution from what are called simple molecules, but which are really composed of a great number of atoms.

Prof. Frankland said he ventured to differ from Prof. Dewar in one point. He thought it might not be impossible by a decomposition of compound molecules to prepare isolated iodine atoms.

Sir Lyon Playfair suggested as a useful line of work the determination of the conditions under which such bodies as nitric peroxide would enter into combination with other compounds.

Prof. Tildén pointed out that a large field lay open to workers in thermo-chemistry, on the one hand in determining the temperatures at which chemical action begins, and on the other the heat-changes of chemical combination and solution at different temperatures.

Rev. Father Perry agreed with Prof. Dewar that some differences in the solar lines were due to difference of level of the luminous vapour. But, on the other hand, the widening of solar lines in the umbra of spots cannot be accounted for in this way. The Astronomer-Royal and Mr. Lockyer have been studying the solar spectrum from the line D to F. The Rev. Father Perry (studying D towards B) has found differences in the lines of the same metal in different spots which could not be attributed to difference of level only.

Prof. Dewar, in answer to Father Perry, stated that the widening of certain lines at the red end of the spectrum might have been anticipated from the results of his own work in the crucible. The supposed allotropic spectrum of magnesium is due to a compound of magnesium and hydrogen. The fact that in the upper regions of the solar atmosphere, where hydrogen and magnesium occur in enormous quantities, this allotropic spectrum is not observed presents a difficulty. Perhaps at the mean temperature of the solar atmosphere this compound is dissociated. If so, somewhere nearer the surface or in the spots a condition of temperature should occur in which the compound should be stable. He hoped Father Perry would succeed in observing this spectrum in the umbra of spots. It had been stated that if our elements are compound substances they should be found decomposed at the enormously high temperatures of the sun; but if it is admitted that the elements are compounded of hydrogen, and that dissociation can occur, the compound vapour is diffused through an atmosphere of hydrogen, one of the products of its dissociation, and is therefore precisely under those conditions in which it is most stable.

##### *Discussion on "Chemical Changes in their Relation to Micro-Organisms"*

Prof. Frankland, in opening the discussion, distinguished between two kinds of chemical action—(1) that in which substances brought into contact mutually undergo chemical change, and (2) that in which chemical change is effected in one substance by contact with another, which itself apparently suffers no alteration. The following definitions were proposed to distinguish animal and vegetable organisms:—(1) A plant is an organism performing synthetical functions, or one in which these functions greatly predominate; it transforms actual into potential energy. (2) An animal is an organism performing analytical functions, or one in which these functions greatly predominate; it transforms potential into actual energy. All micro-organisms appear to belong to the second class. Oxidation is the essential condition of life. There are, however, many other chemical transformations in which potential becomes actual energy, and which therefore can support life. After de-

scribing the chemical changes produced by a large number of micro-organisms, the author concluded that there is no break in the continuity of chemical functions between micro-organisms and the higher forms of animal life. It is true there are apparently certain sharp distinctions between them. The enormous fecundity of micro-organisms and their tremendous appetites seem to separate them from the higher orders of animals. But this distinction is only comparative. It must be borne in mind that an animal like a sheep converts much of its food into carbonic acid, hippuric acid, and water, thus utilising nearly the whole of the potential energy, while the micro-organism as a rule utilises only a small portion. Those micro-organisms which have been chemically studied produce, like the higher animals, perfectly definite chemical changes. The position of these organisms in Nature is only just beginning to be appreciated. It may safely be predicted that there is no danger of their being spoiled by the petting of sentimentalists, yet these lowly organisms will receive much more attention in the future than they have done in the past.

Principal Dallinger referred to the attempted distinction between the lower animal and vegetable forms. In following out the life-history of certain monads he used a nutritive fluid containing no albuminoid substances, but only mineral salts and tartrate of ammonium. Organisms classed by Prof. Huxley as animal were found to live in this mineral fluid. Bacteria of forms which cannot be distinguished by the microscope have very different physiological functions. These Bacteria can be modified physiologically, but not at all readily morphologically; by a slow change it is possible to completely reverse the conditions of the environment of the Bacterium without changing its form. It is most important to study the physiology of Bacteria.

Dr. Macalister pointed out that the experiments made on the conversion of the Bacillus of the hay infusion into the *Bacillus anthracis* had not been confirmed by more exact experiments. The germs of the *Bacillus anthracis* readily diffused themselves through the air of the laboratory, and without the very greatest care it was impossible to avoid contamination of the liquids with stray germs.

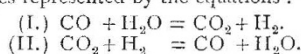
Prof. Dewar referred to the extraordinary behaviour of very small quantities of peroxide of hydrogen on putrescible liquids. One-hundredth of a per cent. of the peroxide perfectly preserved many liquids, keeping them quite clear and without a trace of any Bacteria. The conversion of sugar into anhydrous alcohol and carbonic acid seemed to be unaccompanied by a thermal change, so that an important question arises, Where does the power which effects the change come from? Possibly, like chlorophyll, the Bacteria absorb rays of radiant heat and light. Dr. Engelman has studied the distribution of radiant energy in the spectrum of the sun and flames by the activity of the Bacteria submitted to different parts of the spectrum.

Sir Lyon Playfair regarded it as curious that the products formed in the growth of the higher animals—namely, carbonic acid and urea—should be so much simpler than the products formed by lower organisms.

*Complex Inorganic Acids*, by Prof. Wolcott Gibbs.—This research may be regarded as a series of generalisations of the class of silico-tungstates discovered by Marignac in 1861, and of the analogous class of phospho-molybdates studied by Deville. Scheibler has described two distinct series of phospho-tungstates; the author finds there are at least ten, the highest having the formula  $24\text{WO}_3, \text{P}_2\text{O}_5, 6\text{H}_2\text{O}$ , the lowest the formula  $6\text{WO}_3, \text{P}_2\text{O}_5, 6\text{H}_2\text{O}$ , and that the phospho-molybdates are at least equally numerous, and have a similar range. Corresponding compounds containing arsenic oxide also exist. To generalise these results the author replaced phosphoric oxide by vanadic oxide and antimonio oxide, so as to form vanadio-tungstates and antimonio-tungstates, and the corresponding compounds of molybdenum. Many of these salts are very beautiful. Probably the greater number of oxides of the type  $\text{R}_2\text{O}_5$  form similar compounds. A second series of complex acids contain *two* molecules of the type  $\text{R}_2\text{O}_5$ , so that we have various phospho-vanadio-tungstates and phospho-vanadio-molybdates. The generalisation of the term  $\text{WO}_3$  or  $\text{MoO}_3$  appears also possible, as the author has prepared compounds in which sulphur and selenium replace oxygen in  $\text{WO}_3$  or  $\text{MoO}_3$ . Again, the author finds that phosphorous and hypophosphorous acids enter into similar combinations with tungstic and molybdic acids, and he has also prepared compounds in which the methyl, ethyl, and phenyl derivatives of phosphorous and hypophosphorous acids occur. An attempt to

prepare complex acids containing pyro-phosphoric acid failed, as that acid quickly changed to the ortho-acid; but with meta-phosphoric acid the author succeeded in preparing several new compounds. The author has further shown that the group  $\text{R}_2\text{O}_5$  may be replaced by  $\text{R}'\text{O}_3$ ,  $\text{R}''\text{Cl}_3$ — $\text{R}$  being a metal of the platinum group—and that the chlorine can be replaced by bromine or iodine. The type of silico-tungstates is also capable of generalisation, silica being replaced by a large number of similar oxides, as, for instance, the oxides of selenium, tellurium, platinum, &c. As an instance of the extreme complexity of some of these compound acids, the author gave the body  $60\text{WO}_3, 3\text{P}_2\text{O}_5, \text{V}_2\text{O}_5, \text{VO}_2, 18\text{BaO}, + 150\text{Ag}$ . This body has the enormous molecular weight of 20,066. In conclusion the author stated that in formulating certain compounds containing  $\text{V}_2\text{O}_5$  he found much similar expressions resulted when a part of the  $\text{V}_2\text{O}_5$  was supposed to have the structure  $(\text{V}_2\text{O}_2)\text{O}_3$ ,  $(\text{V}_2\text{O}_2)$  replacing  $\text{W}$  or  $\text{Mo}$ .

*On the Incomplete Combustion of Gases*, by H. B. Dixon.—The author gave a résumé of the work he had done in continuation of the researches of Bunsen, E. von Meyer, Horstmann, and other chemists, on the division of oxygen when exploded with excess of hydrogen and carbonic oxide. The following are the general conclusions arrived at:—(1) No alteration *per saltum* occurs in the ratio of the products of combustion. The experiments made completely confirm Horstmann's conclusion: Bunsen's earlier experiments are vitiated by the presence of aqueous vapour in the eudiometer. (2) A dry mixture of carbonic oxide and oxygen does not explode when an electric spark is passed through it. The union of carbonic oxygen is effected indirectly by steam. A mere trace of steam renders the admixture of carbonic oxide and oxygen explosive. The steam undergoes a series of alternate reductions and oxidations acting as a "carrier of oxygen" to the carbonic oxide. With a very small quantity of steam the oxidation of carbonic oxide takes place slowly; as the quantity of steam is increased the rapidity of explosion increases. (3) When a mixture of dry carbonic oxide and hydrogen is exploded with a quantity of oxygen insufficient for complete combustion, the ratio of the carbonic acid to the steam formed depends upon the shape of the vessel and the pressure under which the gases are fired. By continually increasing the initial pressure a point is reached where no further increase in the pressure affects the products of the reaction. At and above this critical pressure the result was found to be independent of the length of the column of gases exploded. The larger the quantity of oxygen used, the lower the "critical pressure" was found to be. (4) When dry mixtures of carbonic oxide and hydrogen in varying proportions are exploded above their critical pressures with oxygen insufficient for complete combustion, an equilibrium is established between two opposite chemical changes represented by the equations:—



At the end of the reaction the product of the carbonic oxide and steam molecules is equal to the product of the carbonic acid and hydrogen molecules multiplied by a coefficient of affinity. This result agrees with Horstmann's conclusion. But Horstmann considers the coefficient to vary with the relative mass of oxygen taken. (5) A small difference in the initial temperature at which the gases are fired makes a considerable difference in the products of the reaction. This difference is due to the condensation of steam by the sides of the vessel during the explosion, and its consequent removal from the sphere of action during the chemical change. When the gases are exploded at an initial temperature, sufficiently high to prevent any condensation of steam during the progress of the reaction, the coefficient of affinity is found to be constant whatever the quantity of oxygen used—provided only the quantity of hydrogen is more than double the quantity of oxygen. (6) The presence of an inert gas, such as nitrogen, by diminishing the intensity of the reaction, favours the formation of carbonic acid in preference to steam. When the hydrogen taken is less than double the oxygen, the excess of oxygen cannot react with any of the three other gases present—carbonic oxide, carbonic acid, and steam, but has to wait until an equal volume of steam is reduced to hydrogen by the carbonic oxide. The excess of inert oxygen has the same effect as inert nitrogen in favouring the formation of carbonic acid. The variations in the coefficient of affinity found by Horstmann with different quantities of oxygen are due partly to this cause, but chiefly to the varying amounts of steam condensed by the cold eudiometer during the reaction in different experiments. (7) As a general

result of these experiments it is shown that, when a mixture of dry carbonic oxide and hydrogen is exploded with oxygen insufficient for complete combustion, at a temperature at which no condensation of steam can take place during the reaction, and at a temperature greater than the critical pressure, an equilibrium between two opposite chemical changes is established which is independent of the mass of oxygen taken, so long as this quantity is less than half the hydrogen. Within these limits the law of mass is completely verified for the gaseous system composed of carbonic oxide, carbonic acid, hydrogen, and steam at a high temperature.

*On Magnetic Rotation of Compounds in Relation to their Chemical Composition*, by W. H. Perkin, Ph.D., F.R.S.—The author gave a *résumé* of his researches on the magnetic rotary polarisation of compounds in relation to their chemical composition. After referring to the remarkable discovery of Faraday in relation to this subject, and the results obtained by more recent workers in this field, it was shown that no relationship in reference to chemical composition was likely to be found by the usual method of calculating the results of the observation of unit-lengths of the fluid bodies examined, but that, if lengths related to each other in proportion to their molecular weights—making the necessary correction for the difference of densities—were compared, a useful result would probably be obtained. Experiments have proved this to be the case; and in the series of homologous compounds it was found that for every addition of  $\text{CH}_2$  a definite increase of what is called the "molecular rotation" is obtained. Besides this it was found that the rotation also was capable of indicating differences in the construction of organic compounds. Iso, secondary, tertiary bodies give different results from the normal compounds. The compounds containing the halogens were also referred to, and formulæ given by which the molecular rotation of twenty-six series of compounds could be calculated.

*Spectroscopic Studies of Explosions*, by Profs. Liveing and Dewar.—The explosions observed were chiefly those of hydrogen and oxygen and of carbonic oxide and oxygen, and were made in an iron tube fitted with quartz ends. The spectra were both observed with the eye and photographed. Linings of thin sheet metal of various kinds were introduced into the tube. The metals iron, nickel, and cobalt gave many lines in the flash. No other metal gave anything like so many lines as these three, but magnesium gave the *b* group, copper gave one green and two ultra-violet lines, manganese the violet triplet, and chromium three triplets. On the other hand, zinc, cadmium, mercury, aluminium, bismuth, antimony, and arsenic developed no lines in the flash. It appears to be proved that iron, nickel, and cobalt are volatile in some degree at  $3000^\circ$ . It might be possible to establish a spectroscopic scale of temperature if the lines successively developed with increasing temperature were noted. Thus, the iron line T seems to be just developed at  $3000^\circ$ , the aluminium lines at II at a somewhat higher temperature, the lithium blue line may be just seen in the inner green cone of a Bunsen burner, while the green line comes out in the explosion *fla h*. [The photographs of the explosion spectra were exhibited to the Section.]

*On Evaporation and Dissociation*, by Prof. William Ramsay and S. Young, D.Sc.—The authors described experiments made with the object of ascertaining whether the coincidence of the curves which represent the vapour-pressures of stable solid and liquid substances at different temperatures with those indicating the maximum temperatures attainable by the same substances at different pressures, when evaporating with a free surface, holds good also for substances which dissociate in their passage to the gaseous state. The substances examined were chloral hydrate, ammonium carbamate, phthalic acid, succinic acid, aldehyde ammonia, ammonium chloride, nitric peroxide, and acetic acid. It was found that, with chloral hydrate and ammonium carbamate, which cannot exist at all in the gaseous state, the temperatures of volatilisation do not form a curve. When the dissociation was considerable, but not complete, as in the case of phthalic and succinic acids, an indication of a curve was observed at low pressures, but it differed widely both in form and position from that representing the vapour-pressures or pressures of dissociation. As the dissociation increases the curves approach each other more closely, and they appear to be coincident in the case of ammonium chloride and nitric peroxide within the limits of temperature at which observations were made, and at which the amount of dissociation is probably small. With acetic acid very numerous observations proved the perfect coincidence of

the curves. The results appear to be unfavourable to the view that, when liquefaction of a stable substance takes place, gaseous molecules coalesce to form more complex groups of molecules, and that these complex molecules dissociate when the substance is vaporised.

*A Redetermination of the Atomic Weight of Cerium*, by H. Robinson, B.A. Cambridge.—Cerous chloride was prepared by passing hydrochloric acid over cerium oxalate at first gently heated and afterwards raised to redness. The solution of pure chloride was added to a pure solution of silver nitrate, and then dilute solution of silver nitrate was added from a weighed bulb, until the precipitation of chlorine was complete. The liquids were illuminated by yellow light only during the precipitation. As a mean of seven closely concordant results, the atomic weight of cerium is given as 140.2593, that of silver being 107.93.

*The Action of Sulphuretted Hydrogen on Silver*, by Prof. F. P. Dunnington, University of Virginia.—A piece of pure silver, flattened and carefully polished on each face, was placed in the middle of a glass tube two feet long. At each end of the tube a plug of five inches of phosphoric anhydride was confined by glass wool. Pure dry hydrogen was passed through this tube while it was gently heated throughout. The hydrogen was then removed by a Sprengel pump, the silver being heated to  $300^\circ\text{C}$ . This operation was repeated three times, and then pure dry sulphuretted hydrogen was slowly passed through the apparatus for an hour, and the tube finally drawn off at each end. After a few days the silver was slightly darkened near its edges, and after five months the silver was blackened on its edges, while the main portion of the surface was white and bright. [The silver was exhibited to the Section in this state.]

*On Molecular Volumes*, by Prof. W. Ramsay.—The object of this research was to ascertain whether, as has long been taken for granted, the boiling-point of compounds under equal pressures really afforded suitable points for a comparison of their molecular volumes. The experiments made with the following series of compounds—water, methyl alcohol, ethyl alcohol, propyl alcohol, isopropyl alcohol, isobutyl alcohol, and ether—prove that the value of the group  $\text{CH}_2$  is by no means constant. (1) While at the boiling-points of these liquids at low pressures the value is approximately constant (fluctuating between 17.5 and 22), at high temperatures the difference becomes much more marked, attaining at 20 m. of mercury pressure the greatest irregularity; e.g. the difference between the molecular volumes of ether and isobutyl alcohol, two isomeric substances, amounts to a total of twenty units. (2) It was found by experiment that when the liquids were at temperatures corresponding to equal vapour-pressure, but exposed to their critical pressures, no correspondence between their molecular volumes was observable. (3) It was thought possible that if the liquids, still at temperatures corresponding to equal vapour-pressure, could have existed under no pressure, some basis of comparison might be found. From the known compressibility of the liquids it was possible to calculate their volume in this hypothetical state. Although by this method their relative volumes were considerably altered, yet no point of comparison was reached. (4) The author therefore concludes that the boiling-points of liquids, under whatever pressure they may be taken, are not suitable temperatures at which to compare their molecular volumes.

*On Some Phenomena of Solution, Illustrated by the Case of Sodium Sulphate*, by Prof. W. A. Tilden, F.R.S.—The study of the solubility of sodium sulphate in water at temperatures above  $100^\circ\text{C}$ ., leads to the conclusion that the salt dissolves in the anhydrous state. In order to determine whether this salt dissolves in water at lower temperatures in the anhydrous or the hydrated state, the author has made a series of calorimetric measurements of the thermal changes which attend the act of solution of  $\text{Na}_2\text{SO}_4$  in water at temperatures below and above  $33^\circ$  to  $34^\circ$ , the critical point in the curve of solubility.

*Calorimetric Effect of Dissolving  $\text{Na}_2\text{SO}_4$  in n Molecules of Water at  $T^\circ$*

n	T°	C
100	31.7	1740
100	35.4	1522
100	42.85	1342
100	46.1	1071
100	55.0	985

These figures establish the fact that by dissolving anhydrous sodium sulphate in water at temperatures above  $33^\circ$ , the thermal change is still positive, although a diminishing quantity, and

hence that the act of solution is still attended at these temperatures by chemical combination between the salt and the water. These results when plotted out give a line which is nearly parallel to the curve of solubility between these limits of temperature.

*On Calcium Sulphide and Sulpho-carbonate*, by V. H. Veley, M.A.—Calcium oxide, free from metals of the iron group, was obtained by heating perfectly transparent crystals of Iceland spar in a current of hydrogen. This oxide was hydrated in a damp atmosphere free from carbonic acid. The hydroxide was heated to 60° C., and hydric sulphide passed over it. The resulting calcium sulphide and water were weighed, and the synthetic results thus obtained were found to agree closely with the results of the analysis of the calcium sulphide. It is worthy of note that perfectly dry calcium oxide is unaltered by the passage over it of perfectly dry hydric sulphide, and generally the formation of calcium sulphide proceeded the more rapidly the greater the quantity of water originally present in the hydroxide. This result may be due to the formation, at first, either of the hydrosulphide, or the hydroxy-hydrosulphide (CaOH,SH), and the subsequent conversion of either of these substances into the sulphide. The calcium sulphide, prepared as described above, was moistened with water, and hydrogen saturated with carbon bisulphide passed through it. It gradually turned yellow, and finally red, and on exhaustion with cold water a red solution was obtained, from which, on evaporation *in vacuo*, red, deliquescent, prismatic crystals separated. The composition of these crystals was found by analysis to correspond with the formula  $\text{Ca}(\text{OH})_2 \cdot \text{CaCS}_2 \cdot x\text{H}_2\text{O}$ . A solution of this substance gave characteristic precipitates with metallic salts, which the author intends to examine more minutely.

*On the Velocity of Explosions in Gases*, by H. B. Dixon, M.A.—MM. Berthelot and Vieille have shown that in oxygen and hydrogen and several other mixtures of gases the "explosive wave" is propagated at a velocity closely approximating to the mean velocity of translation of the gaseous products of combustion calculated on the assumption that all the heat of the reaction is contained for the moment in the products formed. The mean of a number of determinations with electrolytic gas gave a velocity of 2810 m. per second, the calculated mean velocity of the steam molecule formed being 2831 m. per second. These experimenters found that carbonic oxide exploded either with oxygen or nitrous oxide did not agree with the rule. The author has shown that steam is necessary for the burning of carbonic oxide both with oxygen and nitrous oxide, and that, as the proportion of steam is increased, the rate of inflammation is also increased. Experiments made in a lead tube 55 m. long and 13 mm. in diameter entirely confirmed MM. Berthelot and Vieille's experiments with hydrogen and oxygen. The rate of the "explosive wave" was found to be 2817 m. per second as the mean of several closely concordant experiments at 10° C. With carbonic oxide and hydrogen nearly dry, the explosive wave was not established until the flame had traversed a distance of 700 mm. from the firing-point: the explosive wave was found to have a velocity rather over 1500 m. per second. After the explosion a fine layer of carbon was found to cover the inside of the explosion-tube, showing that at the enormous temperature of the explosive wave carbonic oxide is decomposed into its constituents.

*A Theory of Solution*, by W. W. J. Nicol, M.A., B.Sc.—The author has proposed the theory that the solution of a salt in water is a consequence of the attraction of the molecules of water for a molecule of salt exceeding the attraction of the molecules of salt for one another. It follows, therefore, that, as the number of dissolved salt molecules increases, the attraction of the dissimilar molecules is more and more balanced by the attraction of the similar molecules: when these two forces are in equilibrium, saturation takes place. Any external cause tending to alter the intensity of either of these two opposite forces disturbs the condition of equilibrium, and further solution or solidification ensues. The contraction which occurs on the solution of a salt in water has been regarded as strong evidence in favour of chemical combination having taken place, but the author finds that a further contraction takes place on further dilution, even when the number of water molecules per salt molecule is far in excess of the number in the cryohydrates.

*On the Manufacture of Soda and Chlorine*, by W. Weldon, F.R.S.—Chlorine is at present manufactured exclusively from hydrochloric acid, obtained as a by-product of the manufacture of soda by the Leblanc process. It is owing to this that the Leblanc process has been able to withstand the severe com-

petition of the ammonia process, which gives soda much more cheaply than the Leblanc process, but does not yield either hydrochloric acid or chlorine. The author announces a process for the preparation of chlorine in connection with the manufacture of soda by the ammonia process. The new process consists in decomposing by magnesia the ammonium chloride of the ammonia-soda process, adding magnesia to the resulting solution of magnesium chloride, and so obtaining solid oxychloride of magnesium, which, heated in a current of air, gives off chlorine and leaves magnesia.

*On the Diamond-bearing Rocks of South Africa*, by Prof. Sir Henry E. Roscoe, President.—After an introductory description of the geological and physical aspects of the remarkable diamond-bearing deposits at Kimberley and elsewhere, the author gave the chemical composition of these rocks. The most noteworthy feature of the examination of these rocks is the discovery in the so-called diamond earth of a volatile crystalline hydrocarbon, soluble in ether, which seems to confirm the hypothesis that the Carboniferous shales, which are penetrated by the diamond-bearing pipes, have been the source of the carbon now found in the crystalline state in the diamond. The physical structure of the ash or incombustible portion of the diamond is of a very singular character, and has hitherto not been examined. A careful study of the diamond ash may possibly throw light on the important question of the mode of formation of the diamond.

*Colour of Chemical Compounds*, by Prof. Carnelley, D.Sc.—The colour of chemical compounds is conditioned by at least three circumstances, viz. (1) temperature (Ackroyd); (2) the quantity of the electro-negative element present in a binary compound (Ackroyd); (3) the atomic weights of the constituent elements of the compounds (Carnelley); and that in such a way that the colour passes or tends to pass through the following chromatic scale—white or colourless, violet, indigo, blue, green, yellow, orange, red, brown, black—either by (1) rise of temperature, or (2) increase of the quantity of the electro-negative element in a binary compound, or (3) with increase of the atomic weights of the elements A, B, C, &c., in the compounds  $Ax Ry$ ,  $Bx Ry$ ,  $Cx Ry$ , &c., in which R is any element or group of elements, whilst A, B, C, &c., are elements belonging to the same sub-group of Mendeléeff's classification of the elements. Tables accompany the paper in illustration of the above. Out of 426 cases in which the third of the above rules has been applied, there are but sixteen exceptions, or less than 4 per cent. Finally a theoretical explanation is given which appears to account in a very simple manner for the influence of the above three circumstances on the colour of chemical compounds.

*Notes of Nitrification*, by R. Warington.—He considered the present position of the theory of nitrification, and next gave a short account of the results of recent experiments conducted by him at Rothamsted. Messrs. Schloosing and Müntz, early in 1877, showed that nitrification in sewage and in soils is the result of the action of an organised ferment, occurring in soils and impure waters. The experiments of the author have confirmed the soundness of this theory. The evidence for the ferment theory is now very complete. Nitrification in soils and waters is strictly limited to range of temperature within which the vital activity of the living ferment is confined. It proceeds with slowness at 0°, is at a maximum at 37°, and ceases at 55°. Nitrification is also dependent on plant food suitable for organisms of low character. Further proof of the ferment theory is that antiseptics are fatal to nitrification. Heating sewage to boiling-point, or soil to the same temperature, effectually prevents it. Finally, nitrification can be started in boiled sewage or other sterilised liquid by the addition of a little surface soil or a few drops of a solution already nitrified. These nitrifying organisms have as yet received but little microscopical study.

*On the Liquefaction of Oxygen and the Density of Liquid Hydrogen*, by Prof. Dewar, F.R.S.—The problem of liquefying oxygen and hydrogen, and consequently others of the so-called permanent gases, having been solved by Cailletet and Pictet, the author has since been employed studying the physical characters of these gases in the condensed state. The critical pressures and temperatures at condensation have been determined, and the relation of one to the other is shown to be constant. The merits of various cold producers that could be employed in the process were discussed. Condensed ethylene he considered the best, then condensed nitrous oxide and carbonic acid. The lowest temperature that could be obtained by carbonic acid is about 115° C., and by nitrous oxide 125° C.

*On the Production of Permanent Gas from Paraffin Oils*, by

Dr. Stephen Macadam.—For the last fourteen years the author has devoted much attention to the illuminating values of different qualities of paraffin oils in various lamps, and to the production of permanent illuminating gas from paraffin oils. The earlier experiments were directed to the employment of paraffin oils as oils, and the results proved the superiority of the paraffin oils over vegetable and animal oils, especially for lighthouse service. The later trials were mainly concerned with the breaking up of the paraffin oils into permanent illuminating gas, and the results formed the basis on which paraffin oil gas has been introduced into the lighthouse service of Great Britain, both for illuminating purposes and as fuel for driving engines of fog-horns. The following table shows the results of his investigations on the relative values of the crude, green, and blue oils:—

	Crude	Green	Blue
Gas per gallon in cubic feet ...	98	102	127
Candle power ... ..	50	53	54
Light value of gas from ton of oil given in lbs. of sperm candles	4494	4741	6044

*On the Assimilation of Atmospheric Nitrogen by Plants*, by W. O. Atwater.—It is almost a universal opinion that free nitrogen is not assimilated by plants. He referred to the classic experiments of Boussingault and Lawes, of Gilbert and Pugh, which, commonly regarded as decisive, may have been performed without consideration to certain conditions. Experiments made by the author show that at any rate certain plants grown under normal conditions do assimilate nitrogen. Peas were grown in sand which had been purified by burning and washing, and to which were applied nutritive solutions containing known quantities of nitrogen. The amount of nitrogen supplied to the plant plus the amount contained in the seed was compared after the experiment with the amount given by analysis of the plant and the residual solution. The excess of the latter amount over the former, which in some cases was excessive, represented the nitrogen acquired from the air.

Prof. Gilbert dissented from the conclusion drawn by Prof. Atwater, as he had found that, the greater the care used to prevent foreign matters accumulating on the plants under experiment, the less nitrogen was found in excess of that obtained from the seed and soil.

PROF. FRANKLAND communicated the results of a study of the phenomena attending the discharge of accumulator-cells containing alternate plates of lead peroxide and spongy lead: (1) The energy of a charged storage-cell is delivered in two separate portions, one having an E.M.F. of 2 volts and upwards, the other an E.M.F. of 0.5 volt and under. One of these may be conveniently termed *useful*, and the other *useless*, electricity. (2) The proportion of useful electricity obtainable is greatest when the cell is discharged intermittently, and least when the discharge is continuous. (3) Neither in the intermittent nor continuous discharge at high E.M.F. is the current, through uniform resistance, augmented by rest. At low E.M.F., however, the current, after continuous discharge of the high E.M.F. portion, is greatly augmented, but only for a few minutes. This augmentation of current at low E.M.F. after rest is hardly perceptible when the high E.M.F. discharge has been taken intermittently. (4) The suddenness of fall in potential indicates two entirely distinct chemical changes, the one resulting in an E.M.F. of about 2.5 volts, the other in one of about 0.3 volt. (5) The chemical change producing low electromotive force is the first to occur in charging, and the last to take place in discharging, the cell. It is the change which occurs during what is called the "formation" of a cell, and, for economy's sake, a reversal of this change should never be allowed to take place. (6) Currents of enormous strength can be readily obtained from storage batteries coupled up in parallel, viz. a current of 25,000 amperes from only 100 cells. Such a current reduces to insignificance the output of the large-t dynamo ever built. It is to be hoped that currents of this magnitude will open up new probabilities of research into the constitution of matter.

#### SECTION C—GEOLOGY

*Plan for the Subject-Bibliography of North American Geology*, by G. K. Gilbert, of the U.S. Geological Survey.—The United States Geological Survey is engaged on a Bibliography of North American Geology. The work when completed will give the title of each paper with the title-page of the containing

book, and the number of plates, the whole being arranged alphabetically by authors. There is in contemplation also the simultaneous preparation of a number of more restricted bibliographies, each covering a division of geologic literature. The plan includes abbreviated titles of papers with reference to the pages on which the special subjects are treated, the entries in each bibliography being arranged alphabetically by authors. The selection of topics for treatment in this manner involves the classification of geologic science, and Mr. Gilbert submitted a tentative classification requesting the criticism of geologists.

*Marginal Kames*, by H. Carvill Lewis, A.M., Professor of Geology at Haverford College.—After reviewing the work on American kames, and the theories of the origin of kames, the author describes his investigations of short kames at the extreme margin of the ice-sheet along the line of the terminal moraine in Pennsylvania. These *marginal kames* run *backwards* from the edge of the ice, draining it by a sub-glacial drainage. These kames are discussed in detail, and are thought to represent sub-glacial rivers formed during the melting of the ice-sheet.

*On the Geology of South Africa*, by T. Rupert Jones, F.R.S., F.G.S., &c.—The contour of the south coast is parallel with the outcrop of the strata in the interior, from Oliphant's River (31° 40' S. lat.) on the west coast, southward to the Cape, and then eastward to about 33° 30' S. lat. Here the edges of the strata, formerly bending round to the north, have been swept away to a great extent; but their outcrop is again seen on the east coast at St. John's River (31° 40' S. lat.), where they strike north-eastwardly through Natal, probably far up the country. (1) Gneissic rock and the Namaqualand Schists apparently underlie the others, coming out on the north-west, and exposing a narrow strip on the south coast. (2) Mica Schists and Slates, interrupted by Granites here and there, form a curved maritime band, from about 30 to 70 miles broad, and are known as the Malmesbury Beds (Dunn). These and the beds next in succession (the Bokkeveld Beds, 3) are overlain unconformably by the Table-Mountain Sandstone (4), 4000 (?) feet thick, which forms patches and extensive ridges, and possibly dips over No. 3, to join No. 5, the Witteberg Beds. Nos. 3 and 5, together about 2100 feet thick, lie parallel, and form a concentric inner band. The former contains Devonian fossils; the latter is probably of Carboniferous Age (with *Lepidodendron*, &c.), and forms the Wittebergen and Zwartbergen in the Cape District, and the Zuurbergen in Eastern Province. The Ecce Beds (6) come next; Lower Series, 800 feet; Conglomerate Beds (Dwyka), 500 feet; Upper Series, 2700 feet; conformable with No. 5; in the south much folded, and in undulations throughout, until it passes under the next set of beds, No. 7, in some places 50 miles to the north. The Ecce Beds have fossil wood and plant remains in abundance here and there, but these have not been clearly determined. This series has not been well defined until lately, and even now its limits are not fully determined. It includes the Karoo Desert, and therefore takes in the lowest members of Bain's great Karoo Formation, Nos. 12 and 14 of his map (1856), or the Ecce, Koonap, and part of the Beaufort Beds of Jones (1867). The series No. 7, horizontal and unconformable on the Ecce Beds at the Camdeboo and elsewhere, retains the name of Karoo Sandstones: and after a width of about 40 miles is conformably surmounted by a set of somewhat similar beds (8) in the Stormberg; and thus No. 7 should be regarded as the Lower, and No. 8 the Upper, Karoo Sandstones. The latter end off northwards in the Draakensberg, Natal, Orange Free State, the Transvaal, and Zululand, with the still horizontal Cave Sandstone and associated beds. The Lower Karoo Sandstones probably thin away northwards beneath the others. Below the Karoo Sandstones, and dying out southwards near the Camdeboo (Prof. Green), are the Shales (7\*), which constitute the country around Kimberley, described as the Olive Shales of the Karoo Formation by G. W. Stow. These die out northward against the old rocks of Griqualand-West and the Transvaal. They contain Glacial Conglomerates in their lowest (earliest) beds, in Griqualand-West, just as the Ecce series has its great Glacial Conglomerate (the Dwyka Conglomerate in No. 6) in its lowest portion. As the Stormberg Beds (8) lie upon the Olive or Kimberley Shales (7\*) in the Orange Free State, the Lower Karoo Sandstones (7) must die out northwards. The Kimberley Shales contain some Reptilian bones and plant remains, and some coal on the Vaal; the Karoo Sandstones are rich with *Dicynodont* and other Reptilian bones, and have some Fish remains; and their upper portion (Stormberg) contains Ferns and Cycadeous leaves, and some seams of coal. A fossil mammal also has been found in this series. Throughout its range the