

Thomson first proved by experiment that a magnet acts on the cathode rays through the whole of their course, and does not merely affect the place on the cathode at which they have their origin. He then proceeded to investigate the velocity with which the cathode rays travel, for it seemed that a knowledge of this velocity would enable us to discriminate between two views as to their nature. If they are ethereal waves, we should expect them to have a velocity comparable with that of light; if they are caused by molecular streams, their velocity should be that of the molecules, which we should expect to be very much smaller than that of light. The value found for the velocity of the cathode rays was 1.9×10^7 cm./sec., which is small compared with the velocity of the main discharge from the + to the - electrode. It is much greater than the velocity of mean square of the molecules; it agrees very nearly with the velocity which a negatively electrified atom of hydrogen would acquire under the influence of the potential fall which occurs at the cathode.

On Wednesday, M. Cornu exhibited some brilliant optical experiments illustrating Babinet's principle. Prof. W. Förster described the displacements of the rotational axis of the earth. His results had been deduced by investigating the results of 6000 determinations of latitude in various parts of the globe. The maximum amplitude amounts to nearly half a second, which corresponds to a motion of the pole amounting to 40 or 50 feet. It appears that we are now approaching a period of minimum amplitude.

CHEMISTRY AT THE BRITISH ASSOCIATION

THE meeting of Section B at Oxford will be remembered as one of quite exceptional interest. That portion of the President's address urging upon the University fuller recognition of the claims of science in their curriculum will doubtless have valuable results. Certain of the communications brought forward in the course of the meeting may be described as epoch-making. The presence of a large number of eminent foreign chemists served further to render the proceedings memorable and attractive.

The Committee for preparing an International Standard for the Analysis of Iron and Steel reported that their work was now completed, and that it is proposed to shortly deposit the standards with the Board of Trade, or with some other suitable authority where they will be at the public service.

Prof. Clowes gave an account of his experiments on the proportions of carbonic acid in air which are extinctive to flame, and which are irrespirable. He finds that the flames of candles, oil, paraffin and alcohol are extinguished by air containing from 13 to 16 per cent. of carbonic acid. The flame of coal-gas, however, required the presence of at least 33 per cent. of the extinctive gas, and the flame of hydrogen was not extinguished until the amount of carbonic acid in the air reached 58 per cent. Comparing his experiments with those of Mr. J. R. Wilson on the percentage of carbonic acid required to suffocate a rabbit, Prof. Clowes concludes that air, containing at least 10 per cent. of carbonic acid more than is required to extinguish a candle flame, can be breathed with impunity. By taking advantage of the extraordinary vitality of the hydrogen flame in presence of high proportions of carbonic acid, it is possible to maintain the flame of the composite safety-lamp (previously described by the author), after the oil flame has been extinguished.

Mr. Haldane concluded from some experiments he has made on the respirability of air containing carbonic acid, that the percentage of this gas, considered by Prof. Clowes to be respirable, is too high.

Much interest was shown in the successful experiments of Dr. Lobry de Bruyn, demonstrating the properties of free hydroxylamine. On heating a small amount in a test-tube, a sharp explosion took place. Left exposed to air, it was shown by its action on iodised starch-paper to have become converted into nitrous acid. In a series of test tubes its behaviour with various reagents was demonstrated. With potassium permanganate, and with chromic acid oxidation took place, accompanied by flame; potassium bichromate produced an explosion. The anhydrous sulphates of copper and cobalt were reduced by the substance. Free hydroxylamine was dissolved in anhydrous ether, and sodium added, hydrogen was evolved and the very explosive sodium compound of hydroxylamine produced.

Chlorine and iodine were shown to act spontaneously on hydroxylamine, producing inflammation. It is of interest that hydroxylamine will dissolve many salts which are soluble in water, the order of solubility differing in the two solvents.

Dr. Bernthstein described a new bacterium which occurs in milk, whose chief property is that of peptonising the caseine, thus forming a soluble compound, and rendering the milk transparent, and more readily digested.

On Friday a discussion took place on the behaviour of gases with regard to their electrification, and the influence of moisture on their combination. It was opened by Prof. J. J. Thomson, who exhibited some brilliant experiments illustrating the connection between chemical change and electrical discharge through gases. The gases were confined, under a pressure of about 100 mm. in glass bulbs which were placed in the centre of a coil of wire connecting the exterior of two Leyden jars, the interior coatings of which were connected with the two poles of a Wimshurst machine. As each spark passes between the poles of the machine, a rapidly alternating current is set up in the coil, and hence by induction in the gas. In the case of oxygen it was found that the moist gas gives a vivid incandescence, followed by an afterglow or phosphorescence, on removing the bulb from the coil. With the dry gas, on the other hand, incandescence does not take place. The incandescence, can however, be started in the dry gas by a brush discharge, and if once started continues under the influence of the induced current. With air the phenomenon is reversed; damp air does not glow, dry air will. By making use of two coils in one of which was a beaker of fairly strong sulphuric acid, and in the other a bulb containing moist oxygen, the presence of the acid was shown to prevent the incandescence in the bulb, showing the conductivity of the gas to be much greater than that of the acid. As the glow is only given in gases forming polymeric modifications, it is suggested by Prof. Thomson that the drops of water present may act as conductors causing the original molecules to dissociate. In the case of dry gases this preliminary dissociation can only be brought about by expenditure of a large amount of energy. Alcohol vapour will behave similarly to water, and it becomes of interest to study other solvents.

Mr. Brereton Baker followed with some experiments on the influence of moisture on chemical substances. He showed that ammonia and hydrochloric acid when dry do not combine. He also exhibited tubes containing dry sulphur trioxide and cupric oxide, and dry sulphur trioxide and lime, side by side without action upon one another, a kind of "chemical happy family," as he expressed it. He concludes that the function of moisture is physical rather than chemical from the fact that on heating together a dry mixture of cupric oxide, carbon and oxygen, no action takes place. He has obtained analogous results to Prof. Thomson, by using semi-vacuous tubes, into one end of each of which a platinum wire is fused and which contain a small quantity of mercury. On shaking these tubes in a dark room incandescence takes place in those containing moist oxygen. This is less if nitrogen is present, and ceases if the gas is dry. It was resolved in committee that Prof. Thomson's and Mr. Baker's papers should be published in full.

Dr. Ewan read a paper on the rate of oxidation of phosphorus, sulphur and aldehyde, a portion of which has already appeared in NATURE. The results obtained with aldehyde are free from the uncertainty produced by the correction for the changing rate of evaporation. When proper precautions are taken this reaction goes perfectly regularly at 2c°, and its velocity is proportional to the product of the pressure of the aldehyde and the square root of the pressure of the oxygen. These results are most simply explained by assuming (in accordance with Williamson's theory), that the oxygen first splits up to some small extent into atoms, and that these alone take part in the oxidation.

In the discussion which followed the reading of these papers, Prof. Schuster spoke of the difficulty experienced in passing a discharge through mercury vapour.

Prof. Pringsheim noted the importance of ascertaining the relation between the spectrum given by the discharge, and that of the after-glow in the gas.

Mr. Vernon Harcourt remarked that Mr. Baker's results show that the part played by water in these reactions is probably unique, and is not shared by many, if any, other substances.

With reference to the dissociation of molecules, Mr. Baker

pointed out that the atoms of gases can change their mode of combination independently of water, *e.g.* in the decomposition of potassium chlorate, and in the combustion of carbon disulphide. He suggested that the residual glow is due to the reformation of the original molecules.

Prof. Fitzgerald drew attention to the high specific inductive capacity of water, and contended that Prof. Thomson's explanation of his results meant simply that in a large molecule the atoms can change places.

The President understood Prof. Thomson to hold that water was present in actual drops, and queried whether that could be so in the explosion of carbon monoxide, where a very high temperature is reached.

Prof. Thomson, in his reply, seemed of opinion that minute drops might be present even in the case mentioned by Prof. Dixon. In conclusion he urged the desirability of the preparation of pure compounds in the large laboratories of the country, which might be sent to the physicist for investigation.

Prof. Hartley then described some new methods of spectrum analysis and some Bessemer flame spectra. He has found that if a mixture containing alkalis and alkaline earths be fused with borax or silica, the alkalis are first volatilised and give their characteristic spectra very clearly. For obtaining spectra at high temperatures it has been found useful to heat the substance in the oxy-hydrogen flame on a rod of kainite, pipe-clay, or dried alumina. The elements can be classified according to the type of spectrum given under these conditions. On vapourising alloys, those constituents which, when free, give band spectra, are found to produce line spectra, *e.g.* silver, in an alloy of copper and silver. This is thought to be due to the difference between the vapour pressure of the element when alloyed, and when in the free state.

The spectrum of the Bessemer flame has been studied with special reference to the bands produced by manganese.

Mr. J. W. Thomas read a paper on the chemistry of coal formation, in which he endeavours to trace the connection between the properties of a coal and the character of the vegetation from which it probably originated.

On Monday a large audience assembled to hear the announcement by Lord Rayleigh and Prof. Ramsay of the existence of a new gas in the atmosphere. It appears that certain experiments of Cavendish pointed to the presence, in air, of some substance other than the gases with which we are familiar. Attention was recalled to this substance by the fact that the density of nitrogen obtained from atmospheric air differs by about $\frac{1}{4}$ per cent. from the density of nitrogen obtained from other sources. It was found that if air (with excess of oxygen) be subjected to electric sparks, the resulting nitrous fumes absorbed by potash, and the excess of oxygen by alkaline pyrogallate, there remains a residue which is neither oxygen nor nitrogen, as can be seen from its spectrum. The same gas can be isolated by exposing nitrogen obtained from air to the action of magnesium. As the magnesium gradually absorbs the nitrogen, the density of the residual gas gradually rises to nearly 20. The newly discovered substance constitutes nearly 1 per cent. of the atmosphere, and gives a spectrum with a single blue line much more intense than a corresponding blue line in the nitrogen spectrum.

Sir H. E. Roscoe, in proposing a vote of congratulation on the discovery, spoke of the special interest which attached to it as being the outcome of a purely physical observation.

Prof. Emerson Reynolds noted the place which the new substance, if it proved to be an element, would occupy in Mendeléeef's table among the platinum metals.

Prof. Roberts-Austen suggested that this gas might be the one which is frequently found as a residue among the gases extracted from steel.

The President, in putting the vote of congratulation to the meeting, drew attention to an observation made by Prof. Dewar, that while a mixture of pure liquefied oxygen and nitrogen forms a clear liquid, air in a similar state shows a turbidity. The President suggested that this turbidity might be due to the new gas.

The question is discussed by Prof. Dewar in a letter to the *Times* for August 16, in which he states that the substance causing turbidity does not amount to 1 per cent. of the whole liquid.

The next communication was by Prof. McLeod, on Schuler's yellow modification of arsenic. This is produced as a yellow sublimate when pure arsenic is heated in vacuo. The substance rapidly changes to the black modification.

Some very interesting experiments on the electrolysis of glass were described by Prof. Roberts-Austen. In conjunction with Mr. Stansfield he has found that if a bulb of soda-glass be filled with sodium amalgam and immersed in a vessel of mercury heated in a sand-bath to rather over 200°, on connecting the sodium amalgam and the mercury respectively with the terminals of a battery, sodium will pass from the amalgam through the glass into the mercury. At the end of the experiment the glass is unchanged. If lithium amalgam be substituted for the sodium amalgam, however, a certain percentage of lithium is found in the glass at the end of the experiment, sodium from the glass is driven into the mercury, and the glass is altered in appearance and frangibility. With potassium amalgam and soda-glass no change takes place. These phenomena are believed by Prof. Roberts-Austen to depend on the relative atomic weights and consequent atomic volumes of the elements concerned. Lithium, having a smaller atomic volume than sodium, is able to follow in the galleries left by the atoms of the latter metal; potassium, on the other hand, having an atomic volume greater than sodium, cannot force a passage. From the results he has obtained, using other amalgams, such as those of gold and copper and different kinds of glass, Prof. Roberts-Austen hopes to throw light on the formation of mineral veins in rocks which apparently have not undergone fusion.

Mr. J. W. Rodger gave an account of the experiments which have been conducted by Prof. Thorpe and himself on the relations between the viscosity of liquids and their chemical nature. The method adopted allowed a rapid succession of experiments to be made on the same liquid, at different temperatures. In the case of the fatty acids and alcohols examined, evidence has been found of the existence of molecular aggregates.

Dr. J. H. Gladstone described some experiments on the rate of progress of chemical change. The chief reaction investigated was that which takes place when platinum chloride and potassium iodide are mixed, resulting in the formation of the dark coloured iodide. This change begins rapidly, with no period of inertness or "reluctance." Its completion is much retarded, however, by the presence of potassium chloride. A change which does require time to attain a maximum rate is that which takes place when cuprous oxide is immersed in a solution of silver nitrate, the silver which is produced making its appearance only after some time.

A similar change to the latter was described by M. Paul Sabatier, in which litcharge added to silver nitrate solution is converted into the puce-coloured oxide of lead, with simultaneous deposition of silver.

A paper was read by Mr. Vernon Harcourt, in the name of the late Mr. Percy B. Lewis, on a new and very delicate method for determining the freezing points of very dilute solutions.

Dr. M. Wildermann gave an account of experiments he had made with Mr. Lewis's apparatus, and said that they fully confirmed the predictions of the Van't Hoff Arrhenius theory.

Mr. W. W. Randall described his apparatus for measuring the colour-tint of dilute solutions. His experiments, instituted in order to determine whether dissociation takes place in dilute solutions, are of a qualitative character. At their commencement he was not aware of the careful spectrometric work of Dr. Ewan on the same subject.

Mr. Philip Hartog read a paper on the distinction between compounds and homogeneous mixtures, a portion of which recently appeared in a letter to *NATURE*. He showed that until lately there was no satisfactory experimental criterion for distinguishing easily between true compounds and such mixtures, but the recent work of Raoult showed that the freezing point of a pure compound was always lowered, and its boiling point raised, by any admixture.

Prof. J. A. Wanklyn's paper on new evidence as to the atomic weight of carbon was received with interest, though not with unanimous support, by the chemists present. By fractionating Russian petroleum the author has obtained hydrocarbons of constant boiling point, whose vapour densities point to their all containing carbon atoms of the weight 6.

Dr. J. B. Cohen described a simple form of apparatus for determining carbonic acid in the air, depending on the length of time required by the carbonic acid in a given volume of air to neutralise a known amount of standard lime solution insufficient to combine with all the carbonic acid present.

Mr. A. P. Laurie contributed a paper on "The Diffusion of very Dilute Solutions of Chlorine and Iodine." The interest-

ing result has been obtained that these elements in solution follow the law of gaseous diffusion, the chlorine diffusing twice as fast as the iodine.

Prof. J. W. Brühl gave an account of his investigations on tautomerism. By determining the molecular dispersion of compounds, he has been able to obtain values which are independent of temperature, and thus he has arrived at a sure means of distinguishing between bodies containing the group $\text{HC}=\text{C}=\text{O}$, or "keto" bodies, and those containing the group $\text{C}=\text{C}(\text{OH})$, which he termed "enole" compounds. With simple ketones and di-ketones no tautomerism or change from the keto to the enole form was found to occur. Nor did it occur with the alkyl derivatives of ketonic acids; when, however, the alkyl was replaced by an acid radical in these cases, tautomerism occurred. The author had investigated derivatives of camphor-carboxylic and of malonic and succinic acids, and found the above rule to hold good in these cases, although enolisation was found to depend not only on the number of negative groups present, but also on the position of these in the molecule, and on the simultaneous presence of alkyl groups, which latter sometimes rendered the molecule more stable. An interesting compound had been obtained, namely, mono-brom-formyl camphor, which was a true ketone, and which was the only compound known in which the keto form of the formyl radical was present. In conclusion the assumption of Lahr, that ketonic compounds possess a "labile" constitution, was shown to be untenable, no continuous internal atomic movement being probable. In the case of benzene derivatives, on the other hand, such changes probably occur, and are termed by the author "phasotropic."

Prof. E. Noelting read two papers entitled, respectively, "On Di-nitros Derivatives of the Aromatic Series," and "On the Formation of Indazoles from Diazo-compounds." Both papers dealt with compounds, which showed the dependence of stability on molecular grouping.

Dr. Caro described the method of obtaining a new rhodamine, or pink colouring matter, by the interaction of chloral hydrate and an alkyl derivative of metamidophenol. A salt of a leuco base is formed, which latter on oxidation by ferric chloride gave a blue colouring matter. It was shown by experiment that on heating a solution of this blue compound in water it turned to a fine pink, owing to an intra-molecular change.

A paper followed, by Drs. G. G. Henderson and A. R. Ewing, on "Tetrarsenites." The sodium salt, which was prepared by adding arsenious oxide to acid sodium tartrate, was easily soluble in water, and might be conveniently used for hypodermic injections of arsenic. Other salts had been prepared, and also a solution which probably contained the hypothetical tartrarsenious acid from which they were derived.

Dr. J. B. Cohen read a paper on "The Constitution of the Acid Amides," in which he showed that these might be divided into two classes—those which formed compounds with silver and crystallised in needles or prisms, and those which did not form silver compounds and crystallised in plates. To account for these differences he fell back on Hantzsch's theory of the stereo-isomerism of nitrogen compounds, and concluded that the amides contain a hydroxyl group.

A short discussion followed the paper, in which Prof. Dunstan quoted experiments which he had made on the action of trichloride of phosphorus on acetamide, which did not bear out Dr. Cohen's view of the constitution of the latter body.

Dr. Caro, however, did not consider Prof. Dunstan's experiment conclusive.

The report of the Committee on Isomeric Naphthalene Derivatives was read. Work had been done on chlor-sulphonic and brom-sulphonic derivatives of naphthalene, and the results tended to confirm the previous conclusions of the investigators.

The report of the Committee on the Action of Light upon Dyed Colours was read by the secretary, Prof. Hummel. The colours experimented with this year were chiefly yellows. Of these by far the largest number, ranging from "moderately fast" to "very fast," were to be found among the azo colours. The azoxy colours give good fast tints upon silk and cotton. The fastness of alizarin orange is probably greater than that exhibited by most other colours of the alizarin group. Very few fast yellows are derived from the natural colouring matters. The cultivation of weld, which yields the only fast and, at the same time, bright, natural yellows, is being gradually given up. It is fortunate then that efficient substitutes can be obtained from coal-tar, which, contrary to popular opinion, is the source from

which the greatest number of colours fast to light are derived at the present time.

Dr. W. Meyerhoffer read a paper on "Certain Phenomena of Equilibrium during the Evaporation of Salt Solutions." For a given mixture of salts in a saturated solution it was found that there existed a certain transition temperature above which double decomposition took place. Thus with a saturated solution containing ammonium chloride and sodium nitrate, sodium chloride was formed above 6°C ., while below that temperature no change took place.

GEOLOGY AT THE BRITISH ASSOCIATION.

OF the forty-three papers presented to Section C this year, comparatively few are of lasting importance, geologists having apparently saved up their best work for presentation at Zurich, or else having exhausted themselves at the excellent and successful session of the previous year. The President's address, containing an excellent epitome of the recent progress of mineralogy, was rather fitted for quiet and thoughtful perusal than for reading to a mixed audience, but it will be looked back upon as one of the most valuable of the contributions to the forthcoming volume of *Proceedings*. It was followed up by only one paper dealing with pure mineralogy, that of Mr. H. A. Miers, on a new method of measuring crystals. The two fundamental laws of crystallography—namely, (1) the constancy of the angle in crystals of the same substance, and (2) the law of simple rational indices—seem to be violated by those crystals which are liable to irregular variations in their angles, or those which have the simple faces replaced by complicated "vicinal" planes. Both these anomalies are exhibited by potash- and ammonia-alum. Brilliant and apparently perfect octahedra of these salts show large variations in the octahedron angle; other crystals show low vicinal planes in place of the octahedron faces. If it be true, as is supposed, that the octahedron angle varies in different crystals, it would be interesting to ascertain whether progressive variations can be traced during the growth of a single crystal, and whether some or all of the octahedron faces change their direction in space if the crystal be held fixed during growth.

In order to solve this problem a new goniometer has been constructed, in which the crystal is fixed at the lower end of a vertical axis, so that it can be immersed in a liquid during measurement. This device is in reality an inversion of the ordinary goniometer with horizontal disc; the liquid is contained in a rectangular glass trough with parallel-plate sides; one side is placed rigidly perpendicular to the fixed collimator, and the other is perpendicular to the telescope, which is set at 90° to the collimator. The trough is supported on a table which can be raised and lowered, so that the crystal can be placed at any required depth in the liquid. If the liquid used be its own concentrated solution the crystal can be measured during growth, and the changes of angle, if any, can be observed at different stages. In order that it may be held rigidly, the crystal is mounted, when small, in a platinum clip, which it envelops as it grows larger.

The results derived from the measurement of a large number of alum crystals are as follows:—

(1) The faces of the regular octahedron are never developed upon alum growing from aqueous solution.

(2) The reflecting planes (which are often very perfect) are those of a very flat triangular pyramid (triakis octahedron) which overlies each octahedron face.

(3) The three faces of this triangular pyramid may be very unequal in size.

(4) The triakis octahedron which replaces one octahedron may be different from that which replaces another octahedron face upon the same crystal.

(5) During the growth of the crystal the reflecting planes change their mutual inclinations; the triakis octahedron becomes in general more acute, *i.e.* deviates further from the octahedron which it replaces, as the crystal grows.

(6) This change takes place not continuously, but *per saltum*, each reflecting plane becoming replaced by another which is inclined at a small angle (generally about three minutes) to it.

(7) During growth the faces are always those of triakis octahedra; if, owing to rise of temperature, re-solution begins to take place, faces of icositetrahedra are developed.

These observations prove that the growth of an alum crystal