

were all made in the first century B.C., and were found in wooden coffins, either resting on the heads or surrounding the bodies of the mummies. Among them the following are of special interest:—(1) A very perfect wreath composed of the flowerheads of a species of Immortelle (*Gnaphalium luteoalbum*, L.), called by the ancients "helichrysos," and much used by them in making garlands. Helichrysos wreaths are mentioned by Pliny ("Hist. Nat.," xxi. 96) as having been used in Egypt in Ptolemaic times, also by Theophrastus, Athenæus, Cratinus, &c. (2) Portion of a curious garland made of cones of papyrus pith, lychnis and rose flowers, rose petals, and scarlet berries of the woody nightshade. These latter are mentioned by Pliny as having been employed in garland-making by the Egyptians. (3) Portion of a wreath (of Greek manufacture) made of flowers of the Polyanthus Narcissus (*N. tazetta*, L.). Wreaths made of this flower, the "clustered Narcissus" of the ancients, are often mentioned by early Greek poets. Sophocles thus alludes to them:—

θάλλει δ' οὐρανίας ἐπ' ἄχνας  
ὁ καλλιβοτρός κατ' ἡμᾶρ ἀεὶ  
νάρκισσος, μεγάλαιν θαῶν  
ἀρχαῖον στεφάνωμα.—*Œdipus Coloneus*.

(4) Portion of a wreath made of the flowers of a species of rose (*Rosa sancta*, Richards). (5) A perfect wreath composed of rose petals threaded by a needle on to strips of twine. "Recently," writes Pliny in his history of garlands, "the rose chaplet has been adopted, and luxury has now arisen to such a pitch that rose garlands are held in no esteem at all if they do not consist entirely of petals sewn together with the needle" ("Hist. Nat.," xxi. 8). There are also exhibited: (6) a portion of a wreath composed of twigs of sweet marjoram (*Origanum Majorana*, L.), lychnis flowers, coils of papyrus pith, and pieces of copper tinsel; (7) a portion of a wreath composed of chrysanthemum flowers and leaves, purple cornflowers, and petals of the flower of a species of *Hibiscus*; (8) a portion of a wreath made of flowers of *Matthiola Librator*, L., flowers of the polyanthus, narcissus, and *Hibiscus* petals; (9) portions of two necklaces made of flowers of the date palm threaded on strips of twine; and (10) a fragment of a necklace made of fruits of the date palm. (II.) Among the plant remains are peach stones, dates, and date stones, walnut shells, currants, pomegranates, plums, figs, chick peas, common garden beans and peas, lentils, wheat, barley, and oats. These are probably the remains of the ancient funeral feasts which were held in the Hawara Cemetery by the relatives of the deceased people who were buried there. The whole collection (of which the series here exhibited is only the third part) is fully described by Mr. Percy E. Newberry in Mr. Flinders Petrie's "Hawara, Biahmu, and Arsinoë."

Exhibited by Dr. H. H. Hoffert:—Photograph of lightning flashes taken at Ealing, on June 6, 1889.

### UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Harkness Scholarship, for Geology and Palæontology, has been awarded to T. T. Groom, Scholar of St. John's College.

Mr. J. T. Nicolson, B.Sc. of Edinburgh University, has been appointed Demonstrator in Mechanism and Applied Mechanics.

The Mechanical Workshops Syndicate reports that the practical instruction in engineering and mechanism is producing excellent results in the training of engineers, but that the subject suffers by the lack of a higher technical examination analogous to a tripos, while the workshops do not get all the work they might do, owing to the withdrawal of the University Museums' work.

An examination for Scholarships in mathematics and in chemistry and physics will be held at Peterhouse on October 15. A syllabus of subjects may be obtained from the tutor.

The local lectures in science have been largely attended during the past year; the largest audiences being at Kettering, where astronomy was the subject, and Mr. J. D. McClure the lecturer, and at Lancaster, where Mr. E. A. Parkyn lectured on human physiology.

The Students' Associations have made good progress in many localities, and in Surrey a student, Mr. Broderick, of Guildford, was found sufficiently qualified to repeat the courses in several villages with much success.

### SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 6.—"Notes on the Absorption-Spectra of Oxygen and some of its Compounds." By Profs. Liveing and Dewar.

The authors give a diagram representing the absorption, both in the visible and in the ultra-violet parts of the spectrum, of 18 metres of ordinary oxygen gas at a pressure of about 97 atmospheres—that is, of a mass of oxygen rather greater than is contained in a vertical column of equal section of the earth's atmosphere. Under the circumstances of the experiment the absorptions A and B are very black, and the lines of which they are composed appear much broader than in the ordinary solar spectrum. The other bands are all diffuse at their edges, and, so far as observed, unresolvable into lines. The complete absorption of the ultra-violet rays does not extend quite so far down as the limit of the solar spectrum, though it approaches that limit. There is a diffuse edge of gradually diminishing absorption succeeding the complete absorption, and this fact, together with the rapid diminution of the extent of the complete absorption with decrease of pressure, lead the authors to class this absorption of the extreme rays with the diffuse bands, which, according to Janssen, increase in intensity as the square of the density of the gas. If that be so, it is unlikely that the limit of the solar spectrum is due to the absorption of ordinary oxygen. For though we may suppose interplanetary space to be pervaded by materials similar to our atmosphere, yet they must be in such a state of tenuity that, although they may to some extent reinforce A and B, they will not add sensibly to the strength of the diffuse bands. Moreover, these bands, though identical in position, so far as the blue and less refrangible part of the spectrum is concerned, with bands observed by Brewster and others in the solar spectrum, are seen much more strongly through tubes of compressed oxygen than they appear in the solar spectrum with a low sun. The ultra-violet bands, of which the one near N appears in photographs nearly as strong as the band just above F, and that in the indigo, have not, so far as the authors are aware, been noticed in the solar spectrum. Probably they would appear if photographs were taken with small dispersion when the sun was low.

As the pressure in the tube diminished, the bands rapidly faded; that in the indigo, with an oscillation-frequency or wave number about 2240, was the first to disappear, then those near L and O and that near E. At the same time the limit of the transmitted ultra-violet light advanced from an oscillation-frequency of about 3575 at 97 atmospheres, to 3710 at 50 atmospheres and 3848 at 23 atmospheres. At 20 atmospheres the three bands above C, D, and F, respectively, were still visible, though faint. B remained visible until the pressure was reduced to 2 atmospheres, and A could still be seen, but with difficulty, when the pressure of the 18 metres of oxygen was reduced to 1 atmosphere.

When atmospheric air was substituted for oxygen the authors found that 7 atmospheres was the limit of pressure at which they could certainly distinguish A, and 18 atmospheres the limit at which they could see B. It is a difficult matter to say exactly when an absorption becomes invisible, but the observations on air were made under the same circumstances as those on oxygen, and the two sets of observations were fairly comparable. With air at 75 atmospheres the three bands above C, D, and F, respectively, could all be seen, but that near C only with difficulty. The mass of oxygen and its partial pressure in the tube was in this case less by about one-quarter than that which was required to bring out the bands when oxygen alone was used. The cause of this may be that the development of the diffuse bands depends in some degree on the total pressure of the air, and not only on the partial pressure of the oxygen in it.

The mass of oxygen which when unmixed with nitrogen made A visible would correspond to that in the tube filled with air at 5 atmospheres, and that which made B visible would correspond to air at 10 atmospheres. The differences between these pressures and those which are actually needed to render A and B visible seem too great to be ascribed to errors of observation, and seem to indicate that the addition of the nitrogen has some effect on the absorptive action of the oxygen. On the other hand, Egoroff found that he could still distinguish A when the thickness of air at ordinary pressure was reduced to 80 metres (*Compt. Rend.*, vol. ci. p. 1144). This amount of air corresponds to rather less oxygen than the 18-metre tube would

hold at a pressure of 1 atmosphere. Differences in the sources of light, in the spectroscope, and the observers, would, however, count for a good deal in observations of this kind.

In order to try the influence of temperature on the absorption, the shorter of the experimental tubes, 165 cm. long, was surrounded by a jacket filled with a mixture of solid carbonic anhydride and ether, which was rapidly evaporated by means of a large air-pump. By this means the temperature would be reduced to  $-100^{\circ}$ . The absorption of oxygen at several different pressures up to 104 atmospheres was observed through the cooled tube. The authors were not, however, able to detect any increase of intensity, or other change, in the absorptions which could be ascribed to the cooling. To try the effect of an increase of temperature, the 18-metre tube was surrounded by a jacket and heated up to  $100^{\circ}$  by steam. Heating appeared to render the diffuse bands rather more diffuse and less distinct. On the whole the influence of a change of temperature of  $100^{\circ}$  either way is slight.

The authors have observed repeatedly the absorption of liquid oxygen in thicknesses of 8 and 12 mm. Their observations conform those of Olszewski. 8 mm. of liquid oxygen gives plainly the three diffuse bands above C, D, and F, respectively. With a thickness of 12 mm. the authors were not able to detect any more.

The authors observed the absorption produced by liquid oxygen on the one hand when it was cooled by its own evaporation until the tension of its vapour was only equal to that of the atmosphere—that is, to a temperature of  $-181^{\circ}$ , according to Olszewski—and also when the temperature of the liquid was allowed to rise under pressure up to nearly the critical temperature. There appeared to be no appreciable difference in the absorption under these different circumstances when the oxygen was completely liquid, when it was near its critical temperature, and when it was completely gaseous; so far at least as concerns the three principal bands, which were all that could be seen in the light transmitted by the liquid in a thickness of 12 mm.

It will be observed that taking the density of oxygen at  $-181^{\circ}$  to be 1.124, as given by Olszewski, 12 mm. of the liquid would be equivalent to 9.37 metres of the gas at atmospheric pressure—hardly more than half the thickness required to make A visible. The experiments, therefore, point to the conclusion that gaseous and liquid oxygen have the same absorption-spectrum. This is a very noteworthy conclusion. For, considering that no compound of oxygen, so far as is known, gives the absorptions of oxygen, the persistency of the absorptions of oxygen through the stages of condensation to the state of complete liquidity implies a persistency of molecular constitution which we should hardly have expected.

In order to compare the absorption of ozone with that of oxygen, the authors employed a tube 12 feet long, made of tinplate fitted with glass ends and coated with paraffin on the inside. Ozonized oxygen was passed into the tin tube for some time, while the ozonizer and the tube itself were cooled with ice and salt. The lime-light, viewed through the tube, looked very blue, and also the spot of light thrown from the tube on to a sheet of white paper was equally blue, indicating a considerable absorption of the less refrangible part of the spectrum. The absorption, so far as the visible rays are concerned, appeared to be of a general character, for the spectroscope revealed only four extremely faint absorption-bands. The centres of these bands were at about the wave-numbers 1662, 1752, 1880, and 1990, and their positions with reference to the bands of oxygen are indicated in the diagram. They were so faint as to be seen only with difficulty. When the hot carbon of an arc lamp was substituted for the lime-light they were rather more distinct, but the positions of the edges were undefinable. The light of a gas-lamp was insufficient to show them, and they were no better seen with a single-prism spectroscope of low dispersive power than with the spectroscope employed for observing the oxygen. Only one of these bands is nearly coincident with an oxygen-band—namely, that near E, the faintest of the oxygen-bands. That at wave-number 1752 overlaps the strongest oxygen-band, but not at its strongest part, and has none of the peculiar character of its shading, abruptly increasing on the less refrangible side and slowly decreasing on the other side. Photographs of the spectrum (taken through a tube with quartz ends) showed that the ozone absorbed all the rays above the wave-number 3086—a point between Q and R—while partial absorption extended below Q. It may be said, therefore, that no identity can be traced between the absorptions of ozone and those of ordinary

oxygen. There is no mere displacement of the bands, such as sometimes occurs when a coloured substance is dissolved in different menstrua, nor any such resemblance as subsists between the absorption-bands of the different cobaltous salts derived from different acids.

The four bands which are seen to be produced by ozonized oxygen correspond fairly with the second, third, fifth, and sixth of the bands described by Chappuis as due to ozone (*Annales de l'Ecole Normale*, 2nd ser., vol. xi., May 1882). These four bands, he says, are the first to be seen. The authors have failed to perceive any others with the 3.66 m. tube, though the oxygen was highly ozonized, and maintained at a low temperature. None of the bands were of sufficient intensity to make themselves visible on photographic plates.

It will be noted that the absorption by ozone extends far below the limit of the solar spectrum. By diminishing the proportion of ozone to oxygen in the tube the limit of the transmitted light was continually advanced, as already described by Hartley. The limit of the solar spectrum may, therefore, very well be determined by the average amount of ozone in the atmosphere, as Hartley supposes. The known variations in the limit of the solar spectrum may be taken as confirmatory of this hypothesis, although the comparatively small amount of those variations is certainly less than we should have expected if they measure the changes in the proportion of ozone in the atmosphere.

The absorptions of the class to which A and B belong must be those which are most easily assumed by the diatomic molecules ( $O_2$ ) of ordinary oxygen. Whether oxygen in more complex molecules, as in ozone ( $O_3$ ), may be capable of taking up the corresponding vibrations cannot easily be determined, because we cannot isolate ozone; but since none of the compounds of oxygen with nitrogen, hydrogen, or carbon, or, so far as known, with any other element, exhibit these absorptions, it is very probable that they are peculiar to the molecule  $O_2$ . From this point of view it will be interesting to determine whether liquefied oxygen, which we suppose to have more complex molecules, produces these absorptions. The corresponding spectrum of emission has not as yet been observed, probably because the agency employed to render the gas luminous breaks up the molecules into single atoms of oxygen.

As for the other class of absorption, the diffuse bands, since they appear to have intensities proportional to the square of the density of the gas, they must depend on a change produced by compression. This may either be the formation of more complex molecules, as for example  $O_4$ , corresponding to the deviation from Boyle's law exhibited by oxygen gas, or it may be the constraint to which the molecules are subject during their encounters with one another. Increase of temperature would affect the former, tending to diminish the number of complex molecules formed at a given pressure, but would have no effect on the latter, for though the number of encounters of the molecules in a given interval of time would be greater the higher the temperature, yet so long as the volume was unaltered the ratio of the duration of an encounter to that of free motion would be sensibly unaltered. So far as any change due to temperature has been observed, it is that a rise of temperature slightly weakens the diffuse absorptions.

Reverting to the compounds of oxygen, none of them show the absorptions of oxygen, not even the general absorption of the ultra-violet rays. Some of them, such as water and carbon dioxide, appear quite transparent to ultra-violet rays, while in others, such as nitrous oxide, which show a general absorption of the ultra-violet rays, the limit of transparency is different from that of oxygen. In other respects we may say that there is no resemblance between the absorptions of the compounds of oxygen and those due to oxygen itself. Some of the former have very definite and characteristic absorptions, such as the well-known spectra of the peroxides of nitrogen and chlorine, and we must regard these as indicating the rates of vibration which the molecules  $NO_2$  and  $ClO_2$  respectively are capable of easily taking up. The absence of the absorptions due to oxygen from all compounds of oxygen seems to indicate either that chemical combination is not, as has been supposed by some chemists, a temporary relation in which the molecular groupings are continually breaking up, to be formed anew with ever-changing elementary atoms; or, that the periods of dissociation are very small compared with the periods of association. For otherwise we should expect that such compounds of oxygen as  $CO_2$  and  $NO_2$  must always have amongst their molecules some molecules identical

with those of oxygen and capable of taking up vibrations of the same period. At least we must conclude that little, if any, of the oxygen of these and other compounds is ever out of the influence of the other components.

The authors have re-examined the absorption-spectrum of  $N_2O_4$  at various temperatures, and agree with the conclusions of Bell (*Amer. Chem. Journ.*, vol. vii. p. 32), that  $N_2O_4$ , whether liquid or gaseous, effects only a general absorption at either end of the spectrum, and that the selective absorptions observed with it are due to the presence of  $NO_2$ .

In order to obtain pure  $N_2O_4$ , the tube in which the liquid was sealed was placed in a freezing mixture, and a large part of the liquid frozen; the remaining liquid was then drained as completely as possible into the other end of the tube, and sealed off.

It should be observed that the crystals of  $N_2O_4$  appear colourless, and that when they are melted the liquid and superincumbent vapour are of a very pale yellow colour. As the temperature rises, both liquid and vapour become, as is well known, of a deep orange, and finally of a dark, reddish-brown colour. The authors examined the spectra produced by two thicknesses of liquid and vapour—(1) by that contained in a narrow tube about 1 mm. in diameter, and (2) by that in a tube about 1 cm. in diameter. At  $15^\circ$  to  $20^\circ$  the vapour in the narrow as well as in the wider tube showed the well-known absorption-spectrum of fine, dark lines; no absorption by the liquid in the narrow tube could be detected, and the liquid in the wide tube showed no fine lines, but several faint, very diffuse bands, unresolvable into lines with a spectroscope of three prisms. These bands had their maxima in places where the fine lines of the vapour were most intense and most closely set, so that it might be inferred that they were due to similar molecules in both cases, but that in the liquid the vibrations of these molecules were no longer sharply defined, but modified by the constraint arising from the liquid state. Some parts, however, of the spectrum of the vapour, where the lines were closely set, did not appear to be represented by any definite bands in the liquid. The liquid absorbed a good deal of blue light in a continuous manner, while the vapour only absorbed it selectively. At the red end the limit of the visible spectrum was lower for the liquid than for the gas—that is, there was more absorption of red light by the vapour than by the liquid, so much so that below a certain point the absorption by the vapour appeared continuous.

The narrow tube was next immersed in a wider tube full of glycerine, which was gradually heated. As the temperature rose, the colour of both liquid and vapour deepened, the absorptions of the vapour were stronger, and the liquid gave the same bands as had been before observed with the greater thickness. At still higher temperature the absorption of blue light, both by liquid and vapour, diminished sensibly, until at  $85^\circ$  the groups of lines in the blue had pretty well disappeared from the spectrum of the vapour. In fact, at  $85^\circ$  there was no sensible difference between the actions of liquid and vapour on blue light, it seemed only some continuous absorption. At the red end the difference between the liquid and vapour remained quite as strongly marked as at lower temperatures—if anything, more so; and the absorptions in the orange, yellow, and green were unaltered. At  $90^\circ$  the lines of the vapour in the green began to fade, and at  $100^\circ$  they were very faint; but those in the orange, as well as the corresponding diffuse bands in the liquid, were as strong as before. There was still considerably more absorption of red light by the vapour than by the liquid, as if there were a strong absorption-band in the red of the vapour which was absent in the liquid.

As the temperature rose to  $110^\circ$  all the lines in the vapour had become faint, and at  $115^\circ$  they were no longer discernible, and there was no difference between the spectra of liquid and vapour except in the red, and even here the difference was less marked than at lower temperatures. At  $130^\circ$  no distinction was observable between the spectra of liquid and vapour; there were no lines or bands in either, but a good deal of general absorption. Liquid and vapour were dark, and appeared much of a colour, but the meniscus at the junction was quite evident. The tube was further heated to  $155^\circ$ , but no further change was noticed in the spectrum. On gradually cooling the tube, at  $112^\circ$  the least refrangible band in the orange was seen coming in both in vapour and liquid, diffuse in both. At  $100^\circ$  the usual lines were well seen in the orange, yellow, and citron of the vapour, faint lines in the green, and none in the blue; and subsequently the appearances presented on heating followed in the reverse order.

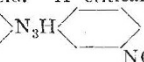
A solution of  $N_2O_4$  in carbon bisulphide gave, in a thickness

of 7 or 8 cm., diffuse absorption-bands in the green and citron, ill-defined as in liquid  $N_2O_4$  and in corresponding positions. In a thickness of 1 cm. these bands were no longer visible.

These observations bear out the supposition that pure  $N_2O_4$  is without selective absorption of the visible rays, and that the absorption observed is due to  $NO_2$ , both in the vapour and liquid, this absorption being modified in the liquid by the state of solution in which the molecules have much less freedom. As the temperature rises, the proportion of  $NO_2$  increases, and at the same time the density of the vapour increases and the freedom of motion of the molecules is diminished, they are less able to assume the more rapid vibrations, and those which they do assume become less sharply defined, so that the lines fade into bands and ultimately into a general absorption.

**Chemical Society, June 4.**—Dr. W. J. Russell, F.R.S., President, in the chair.—Prof. Mendeleeff's Faraday Lecture on the periodic law of the chemical elements, was read by the Secretary, owing to the enforced absence of the lecturer. At the conclusion of the lecture, a vote of thanks to Prof. Mendeleeff was moved by Prof. Frankland, and seconded by Sir F. A. Abel. The Faraday Medal and a purse were then presented by the President to Mr. Anderson, by whom it was received on behalf of Prof. Mendeleeff.

June 6.—Dr. W. J. Russell, President, in the chair.—The following papers were read:—Experimental researches on the periodic law, Part I., by Dr. B. Brauner. The author gives a detailed account of his attempts to determine the atomic weight of tellurium by as many different methods as possible; in all, eleven were adopted, but each gave a different result, varying from 125–140. He eventually succeeded, but with great difficulty, in preparing what appeared to be pure tellurium tetrabromide, and on most carefully analyzing this, obtained the value  $Te=127.64$  ( $O=16$ ). This number, however, is incompatible with the position of tellurium in the periodic system, and having satisfied himself that there were no experimental errors which could account for the discrepancy, the author was forced to conclude that what had hitherto been regarded as pure tellurium contained foreign elements. By submitting tellurium solutions to a systematic fractional precipitation, he has, in fact, succeeded in obtaining a variety of substances, some of which are undoubtedly novel elements. One of these it is proposed to call *Austriacum* (*Austrium*). In all probability this is the *Dzitelium* (212), the probable existence of which was pointed out for the first time by Mendeleeff in his recent Faraday Lecture. From analyses made with material the uniformity of which is not yet quite established, the author is satisfied that the atomic weight of the element in question approaches very closely to that indicated by Mendeleeff. In addition, there is at least one other novel constituent, and this appears to be more or less closely allied to arsenic and antimony. It follows that true tellurium has yet to be discovered, and that its atomic weight and properties remain to be determined.—The amylo-dextrin of W. Nägeli, and its relation to soluble starch, by Mr. H. T. Brown and Dr. G. H. Morris. Amylo-dextrin, described by W. Nägeli in 1874, is prepared by the long-continued action of cold dilute acids on intact starch granules; when purified by dissolution in water and precipitation with alcohol, it forms crystalline spherules, closely resembling those of inulin. The authors consider amylo-dextrin to be analogous in composition to the malto-dextrin previously described by them (*Chem. Soc. Trans.*, 1885, 528), and assign to it the formula  $C_{12}H_{22}O_{11} + (C_{12}H_{20}O_{10})_6$ ; i.e. it may be regarded as constituted of one amylin or mallose group in combination with six amylin or dextrin groups. Soluble starch, with which amylo-dextrin has frequently been confused, is converted into a mixture of maltose and dextrin on treatment with diastase, whilst amylo-dextrin yields maltose exclusively; moreover it is shown that soluble starch is the first product of the action of cold dilute acids on starch, and that this is slowly hydrolyzed to amylo-dextrin, a portion of the starch substance at the same time going into solution as dextrose.—The determination of the molecular weights of the carbohydrates Part II., by the same. As determined by Raoult's method, galactose and malto-dextrin are found to have molecular weights corresponding with the formulæ  $C_6H_{12}O_6$  and  $C_{12}H_{22}O_{11} \cdot (C_{12}H_{20}O_{10})_2$  respectively. For inulin the formula  $2(C_{36}H_{72}O_{31})$  is deduced, and in view of the great similarity in physical properties between inulin and amylo-dextrin the authors are inclined to regard the two substances as closely analogous in composition, representing inulin by the formula  $(C_{12}H_{22}O_{11})_2 +$

( $C_{12}H_{20}O_{10}$ )<sub>5</sub>, although the amylen and amylin groups in each possess very different optical and other properties, and the products of the hydrolysis with dilute acid are very different. It was found impossible to apply Raoult's method to starch-paste; solutions of soluble starch produced so slight a depression that no reliable results can be obtained; a number of fairly concordant results, however, pointed to a molecular weight of 20,000 to 30,000. In order to ascertain whether the failure in this case was due to a high molecular weight, and not to the fact that the method was inapplicable to colloid substances, an arabinic acid, having a rotatory power  $[\alpha]_D = +61^{\circ}16$ , was examined; this gave a molecular weight of 717, thus rendering it probable that the small influence exercised by soluble starch was due to its high molecular weight. Indirect evidence was then sought for by an examination of the dextrins. The authors have previously shown that when starch is broken down by diastase, a re-ting stage in the reaction is reached when the amount of dextrin produced corresponds with one-fifth by weight of the starch taken, and that the molecule of this stable dextrin is one-fifth of the size of the starch-molecule from which it has been derived. Determinations of the molecular weight of this low dextrin pointed to the formula  $20C_{12}H_{20}O_{11}$ , and consequently the formula of soluble starch would be  $5(C_{12}H_{20}O_{10})_{20}$ , and its molecular weight 32,400. The endeavour was also made to apply Raoult's method to the determination of the question whether the dextrins are a series of polymers or whether they are simply metameric. For this purpose a number of the higher dextrins were prepared from starch-transformations which had been stopped at an early stage of hydrolysis. All the numbers obtained show that the freezing method affords no evidence of there being any difference in molecular weight between the high and low dextrins, the numbers being, in fact, almost identical. From a consideration of the results obtained with soluble starch, and with dextrins of varying position in the series, the authors conclude that the evidence points to the conclusion that the dextrins are metameric and not polymeric compounds. They therefore abandon their former working hypothesis of the hydrolysis of starch, and now suppose the starch-molecule to consist of four complex amylin-groups, arranged round a fifth similar group constituting a molecular nucleus. When hydrolysis takes place this complex is broken up, four amylin-groups being liberated, which in turn are capable of undergoing complete hydrolysis into malto-dextrins, and ultimately into maltose, whilst the fifth amylin-group which constituted the nucleus of the original molecule resists the action of hydrolyzing agents, and forms the stable dextrin of the No. 8 equation of the authors' previous papers (Chem. Soc. Trans., 1879, 634; 1885, 539). Each amylin group of the five has the formula ( $C_{12}H_{20}O_{10}$ )<sub>20</sub>, corresponding with a molecular weight of 6480; the molecule of soluble starch being represented by  $5(C_{12}H_{20}O_{10})_{20}$ , corresponding with a molecular weight of 32,400.—Researches on silicon compounds, Part V., by Prof. J. E. Reynolds.—The isomerism of the alkyl-derivatives of mixed diazo-amido-compounds, by Prof. R. Meldola and Mr. F. W. Streatfield. A critical study of the mixed diazo-amide,  $NO_2$  , has served to confirm the

conclusion arrived at by the authors in their previous communications (Chem. Soc. Trans., 1886, 624; 1887, 102, 434; 1888, 664), that this compound and its alkyl-derivatives are perfectly definite, and that they cannot be formed by crystallizing together mixtures of the corresponding symmetrical di-meta- and di-para compounds. The authors restate their original proposition, viz. that every pair of amines,  $X.NH_2$  and  $Y.NH_2$ , can give rise to three isomeric alkyl derivatives—(1) by the action of diazotized  $X.NH_2$  on  $Y.NHR'$ ; (2) by the action of diazotized  $Y.NH_2$  on  $X.NHR'$ ; (3) by the direct alkylation of  $X.N_3H.Y$ . In support of the general truth of this proposition a large number of triplets have been prepared, all of which conform to the rule laid down. The isomerism of these triplets is shown not only by their melting points, but also by their products of decomposition by cold hydrochloric acid. These products have in all cases been examined quantitatively, and the general results are shown by the equations—(1)  $X.N_3.NR'.Y + HCl = X.N_2.Cl + Y.NHR'$ ; (2)  $Y.N_3.NR'.X + HCl = Y.N_2.Cl + X.NHR'$ ; (3)  $2X.N_3R'.Y + 2HCl = X.N_2.Cl + Y.N_2.Cl + X.NHR' + Y.NH.R'$ . From this it appears that the alkyl-derivatives of the mixed diazo-amides always split up like the unalkylated products into a mixture of the two diazo-chlorides and two alkylamines. The most feasible interpretation

of these facts is that the mixed diazo-amides have double the molecular weight usually assigned to them, and in support of this conclusion the authors have discovered that the mixed alkyl-diazo-amides can be synthesized by simply boiling the alcoholic solutions of the other two isomerides of the triplet, thus— $X.N_3.NR'.Y + Y.N_3.NR'.X = (X.N_3R'.Y)_2$ .—The atomic weight of zinc, by Dr. J. H. Gladstone and Mr. W. Hibbert. The authors have observed that when amalgamated zinc is used as anode in a zinc sulphate voltameter, the metal dissolved appears to be free from impurity. Results obtained in different voltameters with the same current showed a very close agreement, and the authors therefore determined the atomic weight of zinc by applying Faraday's law of electrolysis. For this purpose a series of copper, silver, and zinc voltameters were arranged in a simple circuit, and the quantity of zinc dissolved was compared with the weights of deposited silver and copper. The silver and copper voltameters were arranged according to the conditions shown to be best by Lord Rayleigh, Gray, and others. The zinc voltameters were almost of the same form as the silver voltameter of Lord Rayleigh. The anode was a sheet of amalgamated zinc supported so as to rest horizontally on the surface of the zinc sulphate solution, which had a specific gravity varying from 1.18 to 1.21. The mean ratio of the equivalents of silver and zinc is  $3.298 \pm 0.00008$ . Taking the atomic weight of silver as 107.93, this ratio gives 65.44 as the atomic weight of zinc. If silver is taken as 107.66, zinc = 65.29. The copper sulphate voltameter is not so accurate as the silver one, owing to the solvent action of the solution on the copper, and the ratio Zn : Cu given by the experiments (1.0322) is probably rather too high. Adopting Shaw's value for the atomic weight of copper (63.33), this ratio gives 65.37 as the atomic weight of zinc.—The amount of nitric acid in the rain-water at Rothamsted, with notes on the analysis of rain water, by Mr. R. Warrington. The rain of twenty months, analyzed by the copper-zinc method, contained an average of 0.138 of nitrogen as nitric acid per million of water; this is a little higher than that found by Way in 1855–56—namely, 0.12 per million—but is almost identical with that found by Frankland as a mean of his analyses of Rothamsted rain in 1869–70. In a whole year, 1888–89, with a rainfall of 29.27 inches, the quantity of nitric nitrogen in the rain was 0.917 lb. per acre, and the nitrogen as ammonia 2.823 lbs., or a total of 3.74 lbs.—The product of the action of sulphur on resin, by Dr. G. H. Morris.—The vapour-pressures and specific volumes of similar compounds of elements in relation to the position of those elements in the periodic system, by Prof. S. Young. Determinations have been made of the vapour-pressures and specific volumes of the four haloid derivatives of benzene and also of benzene itself, within very wide limits of temperature; benzene, fluobenzene, and chlorobenzene having been heated to their critical points, 288°5 and 286°55 and 360°8 respectively. It is shown that if the four haloid derivatives are compared at such temperatures that their vapour-pressures are equal, the (absolute) temperatures and also the specific volumes bear a constant ratio to each other, whatever the common pressure. But on comparing benzene with one of its haloid derivatives it is found that these simple relations do not hold. The ratios of the absolute temperatures of benzene and fluobenzene corresponding to equal pressures are very exactly expressed, by the equation  $R' = R + c$ , where  $R'$  is the ratio at a pressure for which the corresponding Centigrade temperature of fluobenzene is  $t$ ,  $R = 0.0838$ , and  $c = 0.000313$ .—The vapour-pressures of uquinoline, by the same.

**Anthropological Institute, May 28.**—Mr. F. Galton, F. R. S., Vice-President, in the chair.—Lieut.-General Pitt-Rivers, F. R. S., exhibited some crania found during some recent excavations at Hunsbury Camp, and the Roman villa at Llantwit.—The Rev. H. G. Tomkins read a paper on the Hyksôs, or Shepherd-Kings, of Egypt.—In a paper on the proprietorship of trees on the ground of others, Mr. Hyde Clarke (Vice-President), showed that this was the case in Asia Minor, Melanesia, Borneo (honey-trees), India, Choto Nagpore (moura), and was supposed to be so in parts of China. He proposed the ownership of trees as a more probable origin in jurisprudence of the rights of property than ownership of land, which has no primitive value.

## PARIS.

**Academy of Sciences, June 17.**—M. Des Cloizeaux, President, in the chair.—Numerical results obtained in the study of the vitreous and metallic reflection of the visible and ultra-

violet rays, by M. A. Cornu. The tables here communicated contain the values of the following elements: the wave-length,  $\lambda$ , of the reflected radiation; the principal incidence,  $\mathfrak{Z}$ , which corresponds to a difference of phase,  $\phi$ , equal to  $\frac{1}{4}$  between the two reflected vibratory components; the coefficient H, calculated on the empirical relation between  $\phi$  and  $i$ —

$$H = \sin(\mathfrak{Z} - i) \cot 2\pi(\phi - \frac{1}{4}),$$

in the neighbourhood of the principal incidence; the coefficient  $\epsilon$ ; Cauchy's coefficient of ellipticity,  $\epsilon$ , calculated by the formula  $H = \epsilon \sin^3 \mathfrak{Z}$ ; the product  $2\epsilon \cos \mathfrak{Z}$ , which should be equal to  $\epsilon$  when  $\epsilon$  is very small before unity. The substances studied are selenium, realgar (sulphide of arsenic), senarmonite (crystallized antimony oxide), blende, diamond, fluor-spar, and silver. In general, these numerical data confirm the conclusions already announced, especially as regards the constant increase of the positive and negative coefficient of ellipticity with the refrangibility of the reflected radiations.—On the heats of combustion and formation of the nitriles, by MM. Berthelot and Petit. The nitriles of monobasic acids (acetonitrile, propionitrile, benzonitrile, orthotolunitrile, benzyl cyanide), and those of bibasic acids (oxalic, malonic, succinic, and glutaric nitriles) have been investigated.—A short summary of the thermo-chemical method in its principles and results, as applied to anatomical studies, by M. Sappey. Attention is called to a new method of research, which has for its object the study of the intimate structure of the tissues and organs. The advantages, importance, and absolute necessity of this thermo-chemical method are insisted upon, not as superseding, but as supplementing, older processes. M. Sappey has practised it since 1860, but has hitherto refrained from publishing anything on the subject through his desire to thoroughly verify all the facts before proclaiming the new doctrine. The method itself is based on the fundamental principle of the association of calorific with chemical action in the animal organism; and in its application to the study of the tissues, cuticle, secreting glands, the stomach, ovary, &c., yields highly satisfactory, and in some instances quite startling, results, which cannot fail to challenge the attention of all physiologists.—On the prophylactic method as applied to patients after being bitten, by M. L. Pasteur. In his brief report for the year ending May 1, 1889, the Director of the Pasteur Institute announces the treatment of 1673 subjects, of whom 6 were seized with rabies during, and 4 within a fortnight after, the process. But 3 only succumbed after the treatment had been completely carried out, making one death in 554, or, including all the cases, one in 128.—On the photographic spectrum of Uranus, by Dr. W. Huggins.—Improvements in the graphophone, by Prof. C. V. Riley. Several defects inherent in Mr. Tainter's instrument are stated to have been at last completely removed by Mr. John H. White, of Washington, who has greatly improved the graphophone by employing certain appliances which have been constructed by Prof. Riley on acoustic principles.—Observations of the planet Eucharis (181), made at the west equatorial in the garden of the Paris Observatory, by M. D. Eginitis. The observations are for February 7 and 9, 1889.—On the enlargement of the spectral rays of metals, by M. Gouy. These investigations show that the so-called *narrow* metallic rays present two distinct structures. Some are widened in a uniform manner on both sides (symmetric rays), while others are enlarged almost exclusively on one side (dissymmetric rays). The difference is very marked, and the author has failed to detect any intermediate phase. Nearly all the metallic rays are symmetric, the only exceptions hitherto observed by him being those of sodium and potassium, which belong to the dissymmetric group.—On the limit between polarization and electrolysis, by M. H. Pellat. These researches lead to the establishment of a general law thus announced: Electrolysis begins the moment the double electric layer has been neutralized by polarization.—On actino-electric phenomena, by M. A. Stoletow. Owing to some improvements in the conditions of the investigation, the author has succeeded in determining more accurately the laws of the actino-electric currents in the atmosphere at ordinary pressure. He now thinks that the hypothesis attributing the actino-electric phenomena to the condensed gaseous layers which cover the metallic surfaces, must be rejected.—On the duration of lightning, by M. E. L. Trouvelot. Aided in his observations by photography, the author infers that the flash is not instantaneous, as is generally supposed, but has a perceptible duration beyond the thousandth part of a second, denied to it by Wheatstone.—Researches on the

phenomenon of dispersion in organic compounds, by MM. P. Barbier and L. Roux. The first results of the researches undertaken by the authors on the dispersive power of fluid organic compounds are here communicated. The present note is confined to the monosubstituted derivatives of benzene.—M. G. A. Le Roy describes a new method of preparing nitrites of the alkaline metals; and M. Alphonse Combes contributes a paper on the action of the diamines on the diketones.

## AMSTERDAM.

Royal Academy of Sciences, May 25.—Dr. H. G. van de Sande Bakhuisen in the chair.—M. Lorentz read a paper on the molecular motion of dissolved substances. The values of the osmotic pressure, which M. van't Hoff has deduced from various data, seem to indicate that this pressure is due to the molecular motion of the dissolved body, the mean kinetic energy of a molecule being equal to that of the molecule of a gas at the same temperature. These views were tested by a discussion of molecular equilibrium in a solution under the influence of external forces.—M. van de Sande Bakhuisen exhibited an instrument for determining, by means of rectangular co-ordinates, the right ascensions and declinations of stars on photographs, and the results obtained by measuring, after this method, a photograph by M. Henry. The probable error of each co-ordinate is  $\pm 0''\cdot 043$ . He pointed to the great interest of photographs in the determination of the sun's parallax, and stated that during the coming opposition of Victoria, M. Henry at Paris will make photographs which are to be measured at Leyden.—M. Bierens de Haan announced that the second volume of Huyghens's correspondence will soon be published.—M. Forster treated of the influence of our common salt on the life of pathogenetic bacteria, and stated that, from many and various experiments, he had come to the conviction that, whereas cholera bacilli are very sensible to that salt, and when brought into contact with it very soon die, the typhoid and pyrogenetic bacteria, the bacilli of tuberculosis, and the cattle-distemper bacilli may remain for months buried in common salt without losing their powers of growth and reproduction. The salting of butchers' meat may, therefore, in some cases prove ineffectual. M. Forster further exhibited some preparations, obtained in the hygienic laboratory, which went to prove that neither the bacilli of tuberculosis nor cholera bacilli can develop under the influence of iodoform vapour.

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