exceptionally interesting kind. These compounds are solid non-volatile substances, unlike the metallic carbonyls in this respect, and are represented by the general formula M_2NO_2, where M represents either of the four metals mentioned. Their discoverers propose the name *metaux nitrés*, which perhaps may be conveniently rendered into English as *nitro-metals.*

When a quantity of copper, recently prepared by the reduction of copper oxide in the usual manner by means of a stream of hydrogen or of carbon monoxide, is exposed at the ordinary summer temperature (about 25° being the average temperature of the laboratory while MM. Sabatier and Senderens were conducting these experiments) to a current of the reddish-brown vapour of nitrogen peroxide, it becomes rapidly attacked and converted into a brown substance, considerable heat being at the same time evolved and a large proportion of the nitrogen peroxide absorbed. The brown solid substance produced is found to react with great energy with water, the reaction being accompanied by a copious evolution of nitric oxide, NO. At 30° reduced copper absorbs no less than a thousand times its volume of nitrogen peroxide. Upon analysis of the product it is found to contain about 74 per cent. of copper. A compound of the composition Cu_2NO_2 would contain 73·4 per cent. The nitrogen present was also determined directly, by heating with excess of copper in a stream of carbon dioxide, the nitrogen being measured over caustic potash in the ordinary manner; its amount was found to correspond closely with that demanded by the above formula.

In preparing nitro-copper care must be taken to free the nitrogen peroxide from traces of the vapour of nitric acid, for this acid decomposes the compound with energy, effervescence occurring and the green nitrate of copper being produced. To prevent the deleterious effects of traces of admixed nitric acid vapour the red fumes are allowed to pass first through a column of litharge and afterwards over phosphoric anhydride.

Nitro-copper is unalterable in dry air at ordinary atmospheric temperatures. When heated in pure nitrogen it is dissociated, a temperature of 90° being ample to effect the change; nitrogen peroxide is evolved together with smaller quantities of nitric oxide and nitrogen, and partially oxidised copper remains. One of the most useful properties of nitro-copper is that it may be used for the purpose of liquefying nitrogen peroxide; if a quantity is placed in one limb of a Faraday V-tube and heated, the other limb being cooled, the nitrogen peroxide liberated by the dissociation rapidly collects in the liquid form in the cold limb. If the tube is removed and allowed to stand a short time, re-absorption of the peroxide by the copper occurs. Water reacts with nitro-copper as above mentioned with considerable violence, pure nitric oxide entirely soluble in solution of ferrous sulphate being briskly evolved. The aqueous solution contains cupric nitrate and nitrite, and a sediment of pure copper remains. In moist air, therefore, nitro-copper rapidly deteriorates, becoming enveloped in red fumes and its surface turning green. Hydrogen is without action upon it in the cold, but when heated to 180° large quantities of ammonium nitrite and free ammonia are produced. Dry ammonia gas reacts at the ordinary temperature with some energy upon nitro-copper. White clouds of ammonium nitrate and nitrite and of moisture first make their appearance, then suddenly the mass becomes incandescent and more copious clouds of ammoniacal salts and steam are produced, the residue consisting of copper mixed with ammoniacal oxide of copper. Sulphuretted hydrogen likewise reacts at the ordinary temperature with nitro-copper, heat being evolved, water, sulphur, and a blue sulphide of copper being the products of the reaction.

It would thus appear that nitro-copper is of a kindred nature to the metallic carbonyls, the nitrogen peroxide being held in a similar manner to the carbon monoxide of the latter compounds, and capable of being liberated in a regular manner by the dissociation of the compound by heat. The substance may, in fact, be employed as a convenient means of storing nitrogen peroxide, with the certainty of being able to liberate it by a comparatively slight rise of temperature whenever it is desired to procure some for experimental purposes.

Metallic cobalt reduced from its oxide by means of hydrogen at a temperature below redness is only difficultly pyrophoric in air, not becoming incandescent on admission into air with anything like the readiness of iron. It burns energetically in the cold, however, in nitrogen peroxide. When the nitrogen peroxide vapour is diluted with nitrogen, the heat of the reaction is modified, and the formation of nitro-cobalt occurs in a regular manner, as in the case of copper. It is necessary in the case of cobalt to conduct the preliminary reduction in hydrogen in the same tube as is afterwards used for the preparation of the nitro-compound, in order to avoid re-oxidation of the metal, and it is advantageous to employ as low a temperature for the reduction as possible.

Nitro-cobalt is a black solid substance. Its reaction with water is very violent, but less nitric oxide is produced than in the case of nitro-copper. The rose-coloured solution contains mainly nitrate of cobalt, and a quantity of basic nitrite is found amongst the residual copper. When nitro-cobalt is heated in an atmosphere of nitrogen, a small quantity of nitrous fumes are first evolved, then almost immediately violent deflagration, accompanied by a flame of great brilliance, occurs. The same explosive deflagration occurs if, at the end of the preparation, the supply of diluting nitrogen is shut off before the nitrogen peroxide. When mixed with a combustible substance nitro-cobalt forms a dangerous explosive. If a small quantity wrapped in paper is introduced into an eprouvette filled with mercury at the top of which is a little water, a violent explosion at once results upon the arrival of the small paper packet at the surface of the mercury, owing presumably to the heat of the reaction of a portion of the nitro-cobalt with water causing sudden dissociation of the whole, the organic matter of the paper burning in the gaseous products of the dissociation.

Nitro-nickel is more difficult to obtain in a pure state, for cold reduced nickel reacts so vigorously with nitrogen peroxide that even when the latter is largely diluted with nitrogen a partial oxidation of the metal occurs. Actual incandescent combustion is, however, avoided, and a regular absorption of the peroxide vapour occurs. In a careful experiment a product containing 20 per cent. of NO_2 instead of the theoretical 28 per cent. was obtained. Nitro-nickel closely resembles nitro-cobalt; it is a black substance which reacts with water with evolution of nitric oxide, and which deflagrates with explosive force when heated in a current of inert gas.

Nitro-iron is still more difficult to isolate. When the peroxide is diluted with a very large excess of nitrogen, it is quickly absorbed by reduced iron up to a certain point, when the passage of more peroxide invariably brings about brilliant deflagration and consequent destruction of the product. There is ample evidence, however, that iron does form a nitro-compound of a similar interesting nature to that of the nitro-compounds of copper, cobalt, and nickel above described.

A. E. TUTTON.

PHYSICS AT THE BRITISH ASSOCIATION.

SECTION A met in the well-appointed lecture theatre of the Nottingham University College. Mr. Glazebrook had only just finished his presidential address when an incident occurred which was of interest as showing that members meant business, and were not disposed to allow the authority of the chair to be questioned. Perhaps the experimental work communicated was not of striking novelty or importance, but some of the informal communications and discussions—notably those on electrical theory, the connection between ether and matter, and the teaching of elementary physics—were of great interest, especially to teachers of physics. This was largely due to the active part taken by Lord Rayleigh, Profs. Fitzgerald, Carey Foster, Oliver Lodge, Rücker, and other leading physicists. The discussion occasionally tended to resolve itself into an exchange of ideas around the lecture-table, but as the ideas were for the most part interesting (and energetically expressed) members did not appear to object. At first there was an occasional grumble against Dr. Lodge's innovation of starting at 10 a.m., but the wisdom of the change was shown by the fact that the Section had generally to sit until 2 p.m.

At the first sitting on Thursday (September 14), after the President's address, the "Report of the Committee on Solar Radiation" was communicated. Observations have been made with a thermometer enclosed in a non-conducting case, an image of the sun being thrown upon the bulb. Simultaneous readings of screened thermometers within the case were also taken, and the excess of temperature noted from minute to minute. The thermometer has since been replaced by a thermo-junction, which works very sharply, the readings becoming steady in about six minutes, whereas with the thermometer twenty minutes are required. The readings were calibrated by comparison with an iron-copper junction, heated in paraffin oil and balanced against the actinometer couple. 1° F. was found to be equal to about thirty-six divisions. Another Committee gave detailed reports of magnetic work at the Falmouth Observatory. The other Committees submitted formal reports asking for re-appointment, in some cases with small grants of money.

Prof. G. F. Fitzgerald gave an interesting communication on "The period of vibration of Disturbances of Electrification of the earth." The period of oscillation of a simple sphere of the size of the earth, supposed charged with opposite charges of electricity at its ends, would be about $\frac{1}{17}$th of a second; but the hypothesis that the earth is a conducting body surrounded by a non-conductor, is not in accordance with the fact. Probably the upper regions of our atmosphere are fairly good conductors. In a Geissler tube air is a good conductor, and we know that when part of a gas is transmitting an electrical disturbance the rest of the gas in its neighbourhood becomes capable of transmitting such as well. Extending the analogy, we may assume that during a thunderstorm the air becomes capable of transmitting small disturbances. If the earth is surrounded by a conducting shell its capacity may be regarded as that of two concentric spheres, and is accordingly greater than that of a simple sphere, which would produce a corresponding change in the rate of oscillation. But at the same time the presence of currents in the outer air would alter the self-induction; and calculation shows that the net result is a comparatively slight change in the period of oscillation. If we assume the height of the region of the aurora to be 60 miles or 100 kilometres, we get a period of oscillation of 0·1 second. Assuming it to be 6 miles (or 10 km.) the period becomes 0·3 second. On the sun we might expect very much greater periods of oscillation, but these oscillations would not give rise to radiations. If alternating currents of the kind referred to really travelled north and south around the earth they would give rise to east and west alternating magnetic forces of periods between $\frac{1}{10}$ and $\frac{3}{10}$ of a second. Dr. Lodge has already looked for evidence of such magnetic forces, but on the assumption that the period would be $\frac{1}{17}$ second. The author has calculated what magnetic disturbances would be produced by given charges. A disturbance equal to $\frac{1}{10}$ part of the horizontal force of the earth would correspond to an electrostatic charge of 80 C.G.S. units per sq. cm. Such a charge would reduce the superficial pressure on the earth by an amount corresponding to a weight of 40 gm. per sq. cm. This does not sound probable, but we must remember that it would correspond to a most fearful magnetic storm. A charge of 8 C.G.S. units per sq. cm. would produce a variation of $\frac{1}{100}$ of H, and would not sensibly affect the barometer. The records of existing magnetic observatories are not sufficiently complete to admit of testing the other suggestions made in the paper. Prof. O. Lodge thought that the detection and observation of such magnetic disturbances was work that could only be done in a National Physical Laboratory. If the sun were a conducting body surrounded by a non-conductor, the period of an electrical oscillation upon it would be $6\frac{1}{2}$ seconds. He had hung up in his laboratory a needle and watched it for hours, but the only disturbances observed were due to trains and traffic. He pointed out that the electric vibrations of a molecule, calculated from its size, were more rapid than those required to produce light. He suggested the addition of a jacket like that which Prof. Fitzgerald assumed to exist around the earth; but would this prevent radiation?

The Moon's Atmosphere and the Kinetic Theory of Gases.—Sir Robert Ball has suggested that the absence of any atmosphere investing the moon is a simple and necessary consequence of the kinetic theory of gases. Prof. Liveing has applied this theory to interplanetary and interstellar space, with reference to the chemical constitution of planetary atmospheres. According to Sir Robert Ball the mean molecular speed of oxygen and nitrogen is less than the speed with which a body would have to be projected in order to leave the moon without ever returning; but in the course of collisions between the molecules they frequently attain speeds sufficiently great to enable them to overcome the moon's attraction, and thus escape from the moon's atmosphere. On the other hand, the speed required to permanently leave the earth is one which "it would seem that the molecules of oxygen and nitrogen do not generally ever reach," and therefore the earth retains a copious atmosphere. Mr. G. H. Bryan, in reading his paper on this subject, stated that no statistical calculations had hitherto been made with the object of testing these questions; he was not aware until his paper had been printed that explanations based on the kinetic theory had been suggested as far back as 1878 by Mr. S. Tolver Preston and Mr. Johnstone Stoney. Mr. Bryan has applied the theory to investigate that effect of varying temperatures upon the relative densities of oxygen and hydrogen in a permanent distribution under various conditions; he has also calculated the average number of molecules of gas to every one whose speed is sufficiently great to overcome the attraction of given bodies in the solar system, and gives tables showing the results. Thus for oxygen at 0° C., rather over one molecule in every *three billion* is moving fast enough to fly off permanently from the moon, and only one in every $2·3 \times 10^{329}$ is moving fast enough to escape from the earth's atmosphere; while the sun's attraction, even at the distance of the earth, prevents more than one in every 2×10^{4910} from escaping. In the discussion which followed, Sir Robert Ball stated that the suggestion really did not originate with himself, but were familiar to him as having been discussed many years ago in a paper by Mr. Johnstone Stoney. Among celestial bodies the moon is unique in having no atmosphere. In the earth's atmosphere there is no free hydrogen. Stoney's theory accounts for these effects. On the other hand, in the case of big bodies like Sirius it is hydrogen, and essentially hydrogen alone, which forms their atmosphere.

Grinding and polishing of glass surfaces.—Lord Rayleigh stated that he had been investigating the nature of these processes, and gave a most interesting description of the results. He first pointed out that the process of grinding with emery is not, as is commonly supposed, a scratching process. The normal effect is the production of isolated detached pits—not scratches. The glass gives way under the emery; at the same time the emery gives way under the glass and suffers abrasion. An image seen through glass which has been finely ground (but not yet polished) has perfect definition. And so when the sun is viewed through a cloud the image is sharp as long as there is an image; even when the cloud thickens, the edge appears to be sharp until we lose the image altogether. A glass lens finely ground gives very good definition, but there is great loss of light by irregular reflection. To obviate this the lens is polished, and examination under a microscope shows that in the process of polishing with pitch and rouge the polishing goes on entirely on the surface or plateau, the bottom of each pit being left untouched until the adjoining surface is entirely worked down to it. It appeared interesting to investigate the amount of glass removed during the process of polishing. This was done both by weighing and interference methods, and the amount removed was found to be surprisingly small. A sufficiently good polish was obtained when a thickness corresponding to $2\frac{1}{2}$ wave-lengths of sodium light was removed, and the polishing was complete when a thickness corresponding to 4 wave-lengths was removed. Lord Rayleigh is of opinion that the process of polishing is not continuous with that of grinding, but that it consists in a removal of molecular layers of the surface of the glass. Grinding is easy and rapid, whereas polishing is tedious and difficult. The action of hydrofluoric acid in dissolving glass was also investigated, and was found to be much more regular—that is, has generally been assumed to be by chemists. It was found to be easy to remove a layer corresponding in thickness to half a wave-length of sodium light; and with due precautions as little as one-tenth of a wave-length.

Mr. W. B. Croft exhibited simple apparatus for observing and photographing interference and diffraction phenomena. No bench was used, but the various pieces of apparatus were mounted on the usual stands used for holding lenses, &c. One of these contained a thin aluminium plate with a needle-hole, or the slit of a spectroscope. On this the light of a lamp was focussed by means of a lens. As an observing eye-piece, the eye-piece of a Beck microscope was used and was placed about 2 ft. from the slit or point, the object being introduced between. The stands should be adjusted so that the light proceeds straight into the eye-piece. The whole of the special apparatus required need only cost a few shillings, and with this the usual phenomena of Fresnel's bi-prism, sharp edges, perforated zinc, &c., can be both seen and photographed. Mr. Croft exhibited an admirable series of slides photographed direct with the aid of his apparatus, including interesting examples of the bright central spot in the shadow of a small opaque screen (shot).

On Sun-spots and Solar Envelopes.—The Rev. F. Howlett gave an account of observations and records made by him during the last thirty years of sun-spots, &c., and stated that he had not on a single occasion been able to verify the assertions made in 1769 by Dr. Wilson with reference to the behaviour (through fore-shortening) of the umbra and penumbra as a sun-spot approaches the limb of the sun.

On Friday a report was submitted "On our Present Knowledge of Electrolysis and Electro-Chemistry." This was part of a report which was being drawn up by Mr. W. N. Shaw and Mr. T. C. Fitzpatrick. Many investigators have been engaged upon electrolytic work, but their observations have been published in scattered papers and expressed in a manner which makes comparison of them difficult. The present instalment of the report is the work of Mr. Fitzpatrick, who has at great pains collected all the available information on the electro-chemical properties of solutions in water and has compiled an exhaustive table showing the different chemical salts in solution. Data are given respecting conductivity, temperature coefficients, migration constants of ions (from which one can calculate the rate at which ions travel through solutions), fluidity (the inverse of viscosity), &c. As with falling objects so it is with ions; they travel more quickly through a limpid fluid than through a viscous one. This is just why acids conduct better than salts.

On the connection between the Ether and Matter:—Prof. O. Lodge made a further report as to experiments made with the same apparatus as that which he had described to the Section at the Cardiff meeting in 1891. Ever since Fresnel's time the question has been debated whether—(1) the earth carries with it the ether in its immediate neighbourhood, thus causing a disturbance, or (2) rushes through it, and it through the earth, each being independent and moving independently. Dr. Lodge has been endeavouring to settle this question byfinding out whether a rapidly revolving steel disc (like a circular saw) exercises any drag upon the ether in its immediate neighbourhood. He uses two such discs of tough steel, about a yard in diameter, rotating in parallel planes an inch apart. He is now able to run the discs at the rate of 3000 revolutions per minute; but even at this high speed no effect is observed which can be attributed to any drag of the ether. He has also replaced the discs by an oblate spheroid of wrought iron with a deep channel or groove cut in it and wound with wire; but the rotation of this transversely magnetised mass (weighing about a ton) does not set the ether in motion.

A Mechanical Analogue of Anomalous Dispersion.—Mr. Glazebrook described a mechanical model which he had constructed to illustrate the theory of anomalous dispersion propounded by Sellmeyer, and developed by Helmholtz and Lord Kelvin. The model consisted of rows of balls connected to each other by elastic strings and connected to fixed beams by springs of varying stiffness.

Prof. Fitzgerald communicated a note on Prof. Ebert's method of estimating the radiating power of an atom, and stated that the results show that molecules have a complex structure, otherwise they would radiate very badly. Prof. Fitzgerald holds that the vibration of an atom is the mechanical vibration of a minute bit of the corresponding matter; and that the ionic charges by their corresponding vibrations excite the external radiation.

Lord Rayleigh gave the results of his investigations on the "Theory of Reflection from Corrugated Surfaces," and also, in the absence of the author (Lord Kelvin), read two papers "On the Piezo-Electric Property of Quartz," and "On a Piezo-Electric Pile." These were followed by two interesting communications on electro-magnetic work carried out under the direction of Prof. Hertz in Bonn.

On Electric Interference Phenomena.—Mr. E. H. Barton described experiments on phenomena somewhat similar to Newton's rings, but exhibited by electromagnetic waves in wires. The waves were generated by a Hertzian primary oscillator consisting of two discs of 40cm. diam. each connected by a wire 1m. long to small brass balls between which sparks passed. Opposite these discs, and about 30cm. distant, were two similar ones from which proceeded a pair of parallel copper wires 8 cm. apart and 160 m. long. Along these the waves were propagated and the interference phenomena exhibited. The phenomena in question were produced by hanging sheets of tinfoil on the wires for a certain part of their length. Where the sheets hung the capacity and self-induction of the leads were changed, thus causing a partial reflection of the waves from the *beginning* of this *abnormal* part. But a *second* reflection occurs at the *end* of this part also. Thus interference phenomena were set up, and as the length of the abnormal part was gradually increased the intensity of the transmitted waves was found to periodically increase and diminish. Mr. Barton has recently given (Proc. Roy. Soc.) a theory of these phenomena with which the experiments are in fairly good accord.

On the Passage of Electric Waves through Layers of Electrolyte.—The method and apparatus used in this research were described by Mr. G. U. Yule in a communication to the Royal Society in June last, and an experimental curve was given in the same paper showing that the transmission of trains of electromagnetic waves through a layer of distilled water follows the same law as that of light through a thin plate, *i.e.* that the transmitted intensity varies periodically as the thickness of the plate increases. Similar curves were now given, using dilute solutions of zinc sulphate, alcohol, and a mixture of alcohol and water; in all cases the periodic character of the curve was very well marked. As the transmitted intensity attains its first maximum when the thickness of the layer is half a wave-length, the method may be used to determine dielectric constants. That found for water was 69·5, and for 95 per cent. alcohol 26·7—values agreeing roughly with the high values found by previous investigators.

Mr. J. Larmor referred to a familiar type of caustic curve, produced by reflection from a strip of metal bent into circular form. He pointed out that the source of light need not lie in the plane on which the caustic is thrown—the caustic preserves the same form whether the incidence is direct or indirect.

On Saturday the following papers (mainly of mathematical interest) were communicated:—"On a Spherical Vortex," by Prof. M. J. M. Hill; "Note on the Magnetic Shielding of Two Concentric Spherical Shells," by Prof. Rücker; "The Effect of a Long Tube as a Magnetic Screen," and "The Effect of a Hertzian Oscillation on Points in its Neighbourhood," by Prof. Fitzgerald; "The Magnetic Action of Light," by Mr. J. Larmor (Dr. Lodge characterised this as being perhaps the most suggestive communication made during the meeting, and expressed the hope that it would be further developed and printed); "A Special Class of Generating Functions in the Theory of Numbers," by Major MacMahon; "On Agreeable Numbers," by Lieut.-Col. Cunningham.

On Monday Mr. Horace Darwin exhibited and described the instruments used by the Committee on Earth Tremors. Prof. Milne presented the report of the Committee on the volcanic and seismological phenomena of Japan, and gave a most interesting account of the work done by himself and other observers in Japan.

The greater part of the sitting was taken up by a discussion on the teaching of elementary physics. This was introduced by Prof. Carey Foster, who exhibited and described some simple and cheap apparatus for teaching practical physics. The apparatus shown was well adapted for elementary class-work in heat and electricity. Mr. W. B. Croft followed with a paper in which he described the plan of science teaching at Winchester School, where, by an order of the Privy Council, science is compulsory for almost all the boys. The aim is to arrange for that which may be imposed on all as part of a good education—to supplement thought with the observing faculty. The scheme is also suited for those who may hope to become mathematical physicists and who should in boyhood devote themselves mainly to mathematics. For some boys science forms the best foundation of early education. Public schools are not generally adapted for these cases; but they can well be provided for by a liberal elasticity of system. Prof. O. Lodge read a paper in which Mr. A. E. Hawkins gave the results of his experience of science teaching in public schools, especially in Bedford School. He deprecated the influence of examinations on the teacher's work. Dr. Gladstone considered that apparatus should be not only cheap but simple. To use complicated apparatus was almost as dangerous as to depend upon blackboard work. He agreed with Mr. Buckmaster that too much work was usually expected from a science master. Mr. D. E. Jones emphasised the last point, and stated that instances had come under his notice where science masters had no time to prepare their experiments for class. The idea that science, unlike other subjects, ought to pay for itself, was much to be deprecated; it should not be neglected or abandoned in a school merely because it was costly. The teaching of physics as an educational instrument had not been sufficiently developed; and Continental schools were not much in advance of English ones in this matter. Mr. Jones gave an account of the system of teaching experimental physics as now carried out under Mr. Rintoul at Clifton School. Referring to the subsidising of science teaching in secondary schools, he pointed out that supervision of some kind must accompany public aid. If the evil effects of examinations were to be avoided, an efficient system of public inspection must be developed, and the inspectors should be men with experience of teaching work. Prof. Fitzgerald agreed with this; and Dr. Lodge expressed his regret that head-masters of schools could not be compelled to attend and listen to discussions such as this. The President, in concluding the discussion, said that an effort should be made to replace examinations by an intelligent system of inspection.

The last sitting was held on Tuesday the 19th. The President, as Secretary, submitted the report of the Electrical Standards Committee. This report defines the unit ohm as being the resistance of a column of mercury 106·3 cm. long, and of 14·4521 grammes mass at 0° C. The B. A. unit is equal to 0·9866 of the ohm thus defined. The French authorities had forwarded through M. Mascart four names which were proposed for the ohm of the 106·3 cm., and of these names the committee on the whole preferred "international." The resolutions respecting the electrical units passed at the Edinburgh meeting have now been accepted in Germany, France, Austria, Italy, and the United States, and throughout the British empire. Prof. Carey Foster said it should be known that the work of the Committee was really the work of the President (Mr. Glazebrook).

On Standards of Low Electrical Resistance.—Principal J. Viriamu Jones described the method of determining the ohm devised by Lorenz and used by Lord Rayleigh and subsequently by himself. The method consists in rapidly rotating a copper disc coaxially in the mean plane of a standard coil, the same current being led through the coil and through the low resistance which is to be measured. By varying the speed of rotation the difference of potential between the centre and the circumference of the disc can be made to counterbalance the difference of potential at the ends of the resistance. Prof. Jones pointed out that it is not only the most accurate method of measuring the ohm, but that it is especially suited for the measurement and production of very low resistances. Errors are necessarily produced in stepping down from a standard ohm, say by the potentiometer method, to a resistance of 1/1000 or 1/10,000 of an ohm. The Lorenz method is sufficiently simple and accurate to be adapted for the direct production of low resistances from a rotating disc and standard coil without going through the circuitous process of stepping up to a standard ohm and down again. The difficulty of making a good contact with the edge of the disc is avoided by using a tube with mercury running through it at constant pressure. Difficulties were encountered in using the electrically driven tuning-fork; for although it vibrated uniformly when once started, it was liable to a small change when stopped and started again. A series of experiments on a resistance of 1/2000 of an ohm was given in which the variation from the mean of the extreme values was only 1 in 12,000. Lord Rayleigh expressed his pleasure at the extraordinary accuracy now obtained by the method. In his own experiments the electrically driven tuning fork, instead of being stopped and started again, was kept on all day, and compared at the beginning with a free fork of the same frequency (128). In a recent paper Dorn has criticised the various methods used in the determination of the ohm, and has raised against Lorenz's method the objection that particles of iron in the disc might affect the result by altering the permeability inside the coil. This assumes that the presence of such particles would introduce a direct factor into the result, which would only be true if the whole space inside the coil were so filled.

Apparatus for Comparing nearly Equal Resistances.—Mr. F. H. Nalder exhibited a modified Wheatstone Bridge for comparing nearly equal resistances. In applying the Carey Foster method only a small portion of the usual metre bridge is brought into actual use, and in Mr. Nalder's modification only the part thus used (about 1 decim. long) is provided. This can be replaced by other wires of the same length but of different diameters and therefore resistances; of course the resistance per unit length in each of these is known. The comparison coils are wound in a single bobbin, so as to avoid temperature errors; these, and errors due to the thermo-electric effects, are materially reduced by the compactness of the whole apparatus. Dr. O. Lodge described a new form of galvanometer for physiological purposes. It was designed by himself and made by Messrs. Nalder Brothers. The nerve currents excited by stimuli are exceedingly feeble and, even with the so-called non-polarisable electrodes, the currents under investigation are frequently masked by other effects. Physiologists require an exceedingly sensitive ballistic galvanometer; but they appear generally to use needles which are far too heavy, and galvanometers which are too highly damped, and which manifestly cannot be so delicate as undamped galvanometers. The best form of galvanometer for their requirements is one which contains a very light needle built up of short pieces of highly magnetised steel wire and in which the coils are small and are wound up as close as possible to the needles. The instrument exhibited had four such coils and four needles, forming an astatic system suspended by a quartz fibre in a very weak field. Compared with the usual galvanometers of the same resistance its sensitiveness was at least twice as great. Prof. Boys has shown that excellent definition can be obtained from a small scrap of reflecting mirror; and Lord Rayleigh has shown that a pointer read by a microscope admits of just the same degree of delicacy as the mirror method. As biologists are accustomed to looking through microscopes, Dr. Lodge suggested that they might prefer to observe through a micrometer eyepiece a needle with a bee-sting as pointer. Prof. Fitzgerald suggested that the damping might be further reduced by hanging up the needle in a vacuous tube; and that the polarisations might be swept out by introducing capacities as in cable work.

A Simple Interference Experiment.—There is a well-known interference arrangement in which the object-glass of a telescope is covered by an opaque diaphragm containing two narrow slits. An observer looking through the telescope at a radiant point or slit parallel to the two narrow slits sees a bright central band of white light bordered by interference-bands. Lord Rayleigh had investigated the part played by the telescope in this arrangement, and found that the interference-bands can be equally well obtained by using a plain brass or cardboard tube, having at one end a single slit and at the other a double slit consisting of two fine scratches on a piece of chemically silvered glass about 1/100th of an inch apart. The President thanked Lord Rayleigh for introducing such a simple form of interference experiment, and said it should be more generally recognised that, inasmuch as the eye contains a lens and screen, we can frequently do without an observing telescope in optical experiments.

On Specula for Reflecting Telescopes.—Dr. A. Shafarik communicated the results of investigations which he has carried on since 1870 with the object of producing specula having greater tenacity than that of the Ross telescope. Silvered-glass mirrors produced by the Foucault method suffer rapid deterioration in the air of large towns. The addition of phosphorus is found to make bronzes harder and closer; and the addition of iron, nickel, or cobalt gives them a surprising degree of tenacity. In general the strongest alloys are those which contain the metals in atomistic proportions; and even a small deviation from this proportion appears to diminish the strength considerably. The process of grinding specula differs from that of grinding glass, for alloys are never homogeneous, they are full of crystals, as can be shown by partially dissolving out with acids. The relative tenacity of the Rosse speculum and of two other alloys is given below:—

R	$= Cu_4Sn_1$	Strength	= 1·00
ZN	$= Cu_5Sn_1Ni$	,,	= 6·33
D	$= Cu_4Sn_1$ + 4 per cent Zn.	,,	= 0·52

Several members pointed out that what was really required was a knowledge of the values of Young's modulus for the various alloys investigated, and that it was doubtful whether this was what the author referred to as "strength," or in what way the measurements had been carried out.

Prof. O. Lodge communicated a supplementary note on the ether. He had been asked how could dust polarise light if there was no mechanical connection between ether and matter? But on the electro-magnetic theory there was no difficulty, for light is not an ethereal oscillation but an electrical oscillation, and if the dust has different values of μ and κ from the ether it may affect the wave. Mr. Trouton stated that dust particles act as reflecting resonators with free periods. The President had to confess that he did not fully understand the sense in which Prof. Lodge used the word "mechanical," but considered that a modified mechanical theory (*e.g.* that of the quasi-labile ether) could explain all optical phenomena save those of electro-optics.

A discussion on "The Publication of Scientific Papers" was introduced by the reading of Mr. A. B. Basset's paper. Mr. Basset thinks it highly improbable that scientific societies of position and standing would consent to sink their individuality in order that arrangements might be made for the publication of all important papers in a central organ. The only feasible scheme seems to be the publication of a digest of papers by the cooperation of the various scientific societies; and if thought desirable, papers published in foreign countries might also be included. The development of a well-known periodical is an easier matter than the starting of a new one; and as many authors already send abstracts of their papers to NATURE, it might be worth while considering whether an arrangement could not be made with the proprietors of NATURE by which a supplemental number could be issued (say quarterly) containing a digest of the most important papers published during that period. Mr. J. Swinburne characterised the present system of publishing physical papers as being about as bad as it could be. Papers should be printed and circulated beforehand so as to leave time at meetings for useful discussions. He thought the Physical Society was the most hopeful body to look to, and advised the sending of all physical papers to it. Prof. Fitzgerald agreed with Mr. Swinburne that the publication of titles or indexes alone was unsatisfactory; it was like giving a stone to a man who asked for bread. Abstracts were better, for they gave a little bread with the stone, and he advised the translation of Wiedemann's *Beiblätter* into English. The *Philosophical Magazine* was the personal property of Dr. Francis, and even in the interests of science it was unreasonable to try to evict a man from his own property. The discussion was continued by Prof. Rücker, Prof. Carey Foster, and Lord Rayleigh; and the President in summing up said that the general opinion appeared to be that the matter should be considered by a committee of the Royal Society, if possible in conjunction with the Physical Society.

A new form of air-pump by Prof. J. J. Thompson was exhibited, in which two objects had been aimed at:—(1) to use sulphuric acid instead of mercury; (2) to make the pump self-acting and automatic.

Mr. F. T. Trouton made a communication on a peculiar motion assumed by oil bubbles in ascending tubes containing caustic solutions. A long glass tube was exhibited containing a bubble (about 3 inches long) of sweet oil in a very dilute solution of caustic potash. On inverting the tube the bubble begins to rise, and waves develop on its surface like the knots on a bamboo. These are unstable, and presently resolve into spiral waves which are more stable, because they leave spaces along which the solution can stream past the bubble. If the tube is inclined instead of inverted the bubble crawls up with a slow, caterpillar-like motion.

Dr. R. H. Mill gave a most interesting account of the relation between the temperatures of sea water and air in the Clyde sea area, and illustrated his remarks by an excellent series of slides. After a somewhat unintelligible communication by Mr. E. Major "On the disturbance of a fluid consisting of hard particles by a moving body, with special reference to the ether," the meeting closed with a hearty vote of thanks to the President.

CHEMISTRY AT THE BRITISH ASSOCIATION.

AMONG the advantages of the sectional meetings of the British Association are the opportunites they afford for discussions on scientific matters of special interest, and for the exhibition of experiments and specimens to a wider audience than is often available at the meetings of any single scientific society. The meeting of Section B at Nottingham will be chiefly remembered on account of the success of these two features, and it is to them that attention will be specially devoted in the necessarily brief account which follows.

The papers read on the opening day, after the President's address, were chiefly connected with the chemistry of the metals.

Dr. Gladstone gave an account of some tools and ornaments of copper discovered by Dr. Flinders Petrie and Mr. Bliss in Egypt and Palestine. From the chemical examination of some of these it is concluded that their necessary hardness was imparted by the presence of cuprous oxide.

In a paper by H. Harris and T. Turner a furnace used by the natives of Bengal for smelting iron was described. It is a small shaft furnace, about three feet high, and is capable of producing iron of great purity, from magnetic ore and native charcoal, without the addition of flux.

The Report of the Committee for obtaining an International Standard for the Analysis of Iron and Steel was read by T. Turner. The work of the British Committee is complete as far as the first four standards are concerned. A report, subject to slight revision, has been issued by the American Committee. Their results agree very well with those obtained by the English Committee. Standard 5 is held over for later investigation, after the work of all the committees is complete.

G. J. Fowler read a paper on the preparation and properties of Nitride of Iron. His results confirm those obtained by Stahlschmidt, according to which nitride of iron has a definite composition corresponding to the formula Fe_2N. It dissolves in acid according to the following equation:

$$2Fe_2N + 5H_2SO_4 = 4FeSO_4 + (NH_4)_2SO_4 + H_2$$

By means of this reaction the author, in conjunction with Mr. P. J. Hartog, has attempted to determine the heat of formation of the nitride. Agreeing experiments show it to be formed with evolution of about three calories.

Specimens of Cyano-nitride of Titanium obtained from Ferromanganese were described and exhibited by T. W. Hogg. This substance has been found present, disseminated in microscopic crystals, in every specimen of high percentage ferromanganese examined by the author. It can be obtained by elutriation of the carbonaceous residue, left after solution of the alloy in dilute hydrochloric acid, cupric chloride, &c., and has been identified by qualitative analysis, and by comparison with cyano-nitride of titanium obtained from the blast furnace.

On Friday the communications dealt chiefly with the chemical action of light, and the chemistry of the halogens.

Prof. Hummel read the Report of the Committee for investigating the action of Light upon Dyed Colours. Reds were the colours chiefly examined; of these the eosins were found to be the most fugitive. The great bulk of the fast reds belong to the azo-colours. It was especially pointed out that certain reds obtained from natural dye-stuffs are more fugitive than many artificial colours.

After the reading of this report, the President called upon M. Meslans, chief assistant to M. Moissan, to demonstrate the Method of Isolation, and the Properties of Fluorine. The experiments, which were followed with great interest by a large audience, were eminently successful, The apparatus used was the same as that already described in NATURE. On passing a current rather exceeding twenty-five amperes through the solution of potassium fluoride in hydrofluoric acid cooled by the evaporation of methyl chloride to $-23°$, fluorine was disengaged at the positive pole, its presence becoming evident by the strong smell of ozone. The combustions of silicon, boron, phosphorus, iodine and carbon in the gas, were shown with great success.

M. Moissan's apparatus for determining the density of fluorine was shown. After the vote of thanks to M. Moissan and to M. Meslans, proposed by Sir Henry Roscoe, and seconded by Prof. Thorpe, had been carried by acclamation, a telegram, at the suggestion of Sir Henry Roscoe, was despatched by the President to M. Moissan, congratulating him on the success of the experiments. A reply was afterwards received from M. Moissan regretting his inability to be present at the meeting.

Specimens of M. Moissan's artificial diamonds, and of the Carbide of Uranium which coruscates brilliantly on shaking the bottle containing it, were shown to the section.

Dr. S. Rideal described the results of his experiments to determine the Iodine Value of Sunlight in the high Alps. The experiments were made at St. Moritz in the Engadine, at a height of about 7000 feet, the method being exactly in accordance with that recommended by the Manchester Air Analysis Committee. From comparison of the results with some obtained in Manchester at the same time of year (viz., January), it appears that as much sunshine falls upon St. Moritz in one day as upon Manchester in ten. It is this large amount of sunshine doubtless which renders St. Moritz so favourable a health resort. It appears from some experiments made in the Alps by Prof. Dixon by and Dr. Kohn that above a certain height the amount