run to earth. The remaining article is on the teaching of mathematics in the secondary schools (pp. 127–130), and consists of an extract from the report rendered to the National Educational Society, December 1893, by the Committee on Secondary School Studies.

Meteorologische Zeitschrift, February.—The results of the Swedish International Polar Expedition at Cape Thorsden, Spitzbergen, 1882–83, by Dr. J. Hann. The meteorological results, which have only recently been published, show that the winter temperature is relatively very mild compared with that observed at all the other Polar stations north of 70° N. latitude. In the year commencing September 1882, and ending August 1883, Cape Thorsden, latitude 78° 28″, had the smallest extreme cold, with the exception of Jan Mayen, latitude 71°, while the summer was very cool. The lowest mean monthly temperature was −1°·3 in December, and the absolute minimum −31°·9 in January; the highest mean monthly temperature was 40°·3, and the absolute maximum 56°·5, both in August. The yearly rainfall (including snow), was 7·4 inches; no real hail fell during the year. The daily range of the barometer shows a double period, as in lower latitudes, but the maxima and minima occur at different hours; the day maximum occurs about 1h. p.m., and the minimum about 6h. a.m., and there is a second maximum from 10h. p.m. to midnight, and a second minimum about 6h. p.m. In summer the amplitudes are much smaller than in winter; the day maximum then occurs from about noon to 1h. p.m., and the afternoon minimum about 6h. p.m. The prevalent wind directions are east and west; in summer the south-west wind is most frequent, and in winter north-west and east. The daily range of wind velocity is very marked in summer, the maximum occurring about 1h. p.m., and the minimum about 1h. a.m.; while the reverse obtains in winter, but with less regularity.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 1.—"Terrestrial Refraction in the Western Himalayan Mountains." By General J. T. Walker, C.B., F.R.S.

In the operations of the great Trigonometrical Survey of India it is customary to determine the coefficient of refraction by reciprocal vertical observations between contiguous stations on the sides of all the principal triangles, and also as many as possible of the secondary triangles.

The values of the coefficient thus obtained for the operations in the Western Himalayas—between the meridians of 73° and 80° east of Greenwich—have been grouped together for comparison in successive ranges of 2000 feet of altitude between the elevations of 5000 and 21,000 feet above the sea-level. The operations happen naturally to have been divided into two sections; for the regions lying between the great snowy ranges on the southern face of the Himalayas and the plains of India were first completed, and some time subsequently the still higher regions to the north, extending up to the Karakoram and Kuenlun Ranges, which look down on the plains of Turkestan. The first portion appertains to what is called the N.W. Himalyan Series, the second to what is called the Kashmir Triangulation. Thus the values of the coefficients of refraction were obtained separately for each section, and the results show that at each range of altitude the coefficient of refraction was greater in the Southern than in the Northern Section; also that from the height of 13,000 feet upwards the coefficient decreased in magnitude, as it theoretically should do, in the Northern Triangulation, but, on the other hand, in the Southern it increased until it became twice as great as in the Northern. These differences of behaviour in the two regions are very curious and difficult to account for. They point to some difference in the atmospheric conditions to the north and south of the outer Himalayan Range, and this may possibly arise from the circumstance that the atmosphere to the south is more heavily laden with moisture than the atmosphere to the north; for the great southern range is the first to receive the clouds which come up from the Indian Ocean, and which are the chief source of Himalayan moisture; these clouds are mostly condensed into rain on the southern face of the range, and thus only a comparatively small portion of their contents is carried on beyond into the more northerly regions. Whatever the cause, the fact is very remarkable that the coefficient of refraction has a minimum value at an altitude of 20,000 feet on the north side of the Himalayan Ranges, and a maximum value at the same altitude on the south side.

"On a Spherical Vortex." By Dr. J. M. Hill, Professor of Mathematics at University College, London.

The nature of the irrotational motion of an infinite mass of frictionless fluid, in which a solid sphere is moving, is well known. The object of this investigation is to show that continuous motion throughout space is possible if the solid sphere be replaced by a spherical mass of rotationally moving fluid. This spherical mass is the spherical vortex of the investigation. Its centre moves with uniform velocity along a straight line, which may be called the axis of the vortex. The surfaces inside the vortex which contain the same particles of fluid throughout the motion are ring-shaped surfaces of revolution about the axis, but are not anchor-rings. The molecular rotation at any point of the vortex is proportional to the distance of the point from the axis. The cyclic constant of the spherical vortex is equal to five times the product of the radius of the sphere and the uniform velocity with which the vortex moves along its axis.

Dr. E. L. Mellus made a preliminary report of the results of experimental investigation of the central nervous system of the monkey (*Macacus sinicus*) at the pathological laboratory of University College. Small portions of the cortex cerebri were removed from the left hemisphere, amounting in each case to about 16 sq. mm. At the end of three weeks the animals were killed, and the resulting degeneration traced by Marchi's method. Two foci of representation were selected for excision: the focus for the movements of the hallux, and the focus for the movements of the thumb. In the former, degeneration had taken place extensively throughout the pyramid of the left side down to the decussation in the cervical region, where the degenerated fibres were seen to divide, the greater portion, about two-thirds, crossing over to the opposite (right) lateral column, the remainder passing through the grey matter to the lateral column of the left side. This degeneration was maintained throughout the entire cord to the lower lumbar region. In the case of the removal of the thumb centre similar degeneration was observed, though the number of degenerate fibres was less than in the former. At the decussation the tract also divided, though the proportion of fibres going to the left lateral tract was much less than in the case of the hallux, and there was no degeneration of the cord below the level of the second dorsal nerve.

Mathematical Society, March 8.—Mr. A. B. Kempe, F.R.S., President, in the chair.—The following papers were read:—Groups of points on curves, by Mr. F. S. Macaulay. In the earlier part of the paper a proof is given that any n^{ic} through all the points of intersection of two given curves C_l, C_m of orders l and m is necessarily of the form

$$S_n \equiv C_l S_{n-l} + C_m S_{n-m} = 0$$

but the chief part of the paper is an investigation of the amount of independence of a group of points on a given curve which are residual to the partial intersection of the given curve by another curve of any order. The question may be expressed thus:—"If three curves C_l, C_m, C_n $(l \not> m \not> n)$ have N points common (N being not less than $\frac{1}{2}l.l+3$), what is the amount of independence of the remaining points common to C_l, C_n (and those common to C_n, C_l) for curves of any order passing through them, and what is the number of absolute relations that connect either of the above groups of points among themselves?" The method of investigation is geometrical, *i.e.* it does not depend on the solution of any equations or on the investigation of the properties of a curve from its equations.—On a simple contrivance for compounding elliptic motions, by Mr. G. H. Bryan. The author exhibited a number of "pendulum curves" drawn with a very simple arrangement based on the principle of a pendulum curve-tracer that he saw exhibited at the British Association meeting at Nottingham. The paper to be drawn on is placed on a heavily weighted board suspended from two points overhead by strings attached to its four corners in such a way that it can swing in any direction without twisting round. From the under-side of the board is suspended a weight, thus giving two periods of oscillation. The pen is attached to a triangular framework, hinged to fixed supports, and carefully counterpoised. The pen thus rests gently on the paper, which moves about underneath. The author uses a kind of "reservoir pen,"

formed by bending down the nib of an unfinished and unhardened barrel pen, so as to rest against the under-side of the nib of an ordinary fine grey steel pen, the space between the two nibs holding sufficient ink to draw the finest and most elaborate patterns without the ink running into blots. The most beautiful curves are those obtained by compounding two circular motions whose periods are nearly but not quite in the proportion of, say, two to one. To do this, however, a certain amount of skill is requisite in starting the machine.—On the buckling and wrinkling of plating supported on a framework under the influence of oblique stresses, by Mr. G. H. Bryan. The present investigation is chiefly interesting as forming an addition to the small class of soluble problems in which the question of stability arises in connection with the theory of elasticity. In a previous communication the author discussed the kind of buckling which arises when a rectangular plate has to support thrusts in its own plane, applied perpendicularly to its edges, and of sufficient magnitude to render the plane form unstable. The problem now considered is that of a sheet of plating of indefinite extent supported on equidistant parallel ribs, or on a rectangular framework formed by two such sets of ribs crossing each other, and which is compressed by thrusts applied in any direction not necessarily perpendicular or parallel to the ribs. Let the plating be supported on parallel ribs at distances b apart, and let it be compressed by a thrust P (per unit length measured in the plane of the plate) in a direction making an angle α with the ribs. Then using C to denote the cylindrical rigidity of the surface, the conditions of instability may be summed up as follows:—

(1) If $\alpha < 30°$, the plane form will become unstable when

$$P > \frac{4\pi^2 C}{b^2}$$

and wrinkles will then appear on the surface. These wrinkles will run in directions perpendicular to the direction of P (*i.e.* at an angle $90° + \alpha$ with the ribs, and will consist of alternate elevations and depressions, the lines separating which will be at distances b apart. In other words, the wrinkles with the ribs will divide the plate into rhombi, in which the displacements will be alternately to one side and to the other of the plane form.

(2) If $\alpha < 30°$, the same form will become unstable if

$$P > \frac{\pi^2 C}{b^2 \sin^2 \alpha}$$

and the plating will then buckle into simple corrugations running parallel to the ribs, the displaced form of the plate being a cylindrical surface, of which the section perpendicular to the ribs is a curve of sines. The corresponding results are also worked out for a plate supported on a rectangular framework. A simple rough-and-ready illustration of these results is afforded when a sheet of paper is thrown into wrinkles.—On the motion of paired vortices with a common axis, by Mr. A. E. H. Love. One of the difficulties of the application of the vortex atom theory to problems of radiation lies in the great frequency of all the modes of oscillation of a single ring. The periods are all of the order of magnitude of the time taken by the ring to move over a distance equal to its diameter, and theories of radiation appear to require the existence of very much longer periods. It is not unlikely that such periods may depend on the relative motions of the constituents of a molecule or molecular group consisting of several ring atoms. The simplest case is that of two rings on the same axis passing through each other alternately. The period of this motion when the rings have very different diameters would be very difficult to determine, but it is probable that its order of magnitude can be obtained by considering the corresponding problem in two dimensions. A pair of cylindrical vortices of equal and opposite strengths moves perpendicularly to the plane joining the vortices, and thus behaves like a single ring. Two such pairs with their planes parallel can pass alternately through each other. The case considered is that in which all the vortices are of equal strength (disregarding sign). It is proved that the relative path is always such that, at some instant, the four vortices are in a straight line at right angles to the axis of symmetry, or one pair is passing through the other. It is proved that the relative motion is periodic provided the ratio of the breadth of the wider to that of the more contracted pair, at the instant when one is passing through the other, is less than $3 + 2\sqrt{2}$. The curves described by either vortex of one pair relative to the homologous vortex of the other pair are found. These curves are very nearly ellipses, with their major axes parallel to the axis of symmetry, and they tend to become very elongated when the condition for the motion to be non-periodic is nearly fulfilled, but they are very nearly circular when the ratio of the breadths of the pairs at the instant when one is passing through the other is as great as 2 This result seems to have some bearing on the theoretical conditions of chemical combination. The length of the period is proved to be $\frac{4\pi c^2}{m}\frac{(1+\kappa')^2}{\kappa'(1-\kappa')}(E - K\kappa')$, where m is the strength of one of the vortices, $2c$ the mean breadth of the two pairs, E and K are complete elliptic integrals of the second and first kinds of a certain modulus κ, and κ' is the complementary modulus. The modulus κ' is $(6Rr - R^2 - r^2)/(R + r)^2$, where $2R$ and $2r$ are the breadths of the pairs at the instant when one is passing through the other. The expression for the period is discussed in particular cases, and it is shown that if the order of magnitude of the corresponding period for two vortex rings is the same as that for two vortex pairs, it is in fact long compared with any period of oscillation of a single ring.—On the existence of a root of a rational integral equation, by Prof. Elliott, F.R.S.

DUBLIN.

Royal Dublin Society, February 21.—Prof. Arthur A. Rambaut, Astronomer Royal for Ireland, in the chair.—Mr. W. E Adeney read a paper on the reduction of manganese peroxide in sewage. The author stated that freshly precipitated peroxide of manganese, when mixed with sewage matters, and allowed to air-dry slowly, becomes gradually decomposed into manganous carbonate. He gave an analysis of some manganous carbonate, formed in this way, showing that the reduction of the peroxide is complete when it is exposed in small heaps to the air in the course of about three months.—A paper on eozoonal structure of the ejected blocks of Monte Somma, by Dr. J. W. Gregory and Prof. H. J. Johnston-Lavis, was communicated to the Society by Prof. G. A. J. Cole. The authors show that the limestone-blocks of Mesozoic age in Monte Somma have frequently become metamorphosed into crystalline masses consisting of alternating bands of calcite and various silicates. The authors regard the silica, magnesia, &c. as derived from the igneous rock by chemical interpenetration and interaction. Where the silicate, as often happens, is olivine (montecellite), or a pyroxene, a complete simulation of the structure of *Eozoon canadense* is produced. The layers of silicates occur parallel to the surfaces of any igneous vein that may have intruded into the limestone, and they become closer to one another in the areas farther removed from contact. The "proper wall," the "stolons," and in places the "canal system" of eozoon are recognisable under the microscope; and the authors adduce evidence to show that the typical eozoonal limestone of Canada may have arisen similarly as a product of contact metamorphism.—Prof. Cole then presented a paper upon derived crystals in basaltic andesite of Glasdrumman Port, co. Down. The author described a large composite dyke showing at this point a band of andesite on each side of it, from 4 to 17 feet wide, and a more recent dyke of eurite in the centre, 36 feet across. The eurite includes numerous blocks of andesite, and sends off veins into it; but the pyroxene and glass of the latter rock have become remelted at the contact, a delicate interpenetration of the two magmas has occurred, and the porphyritic crystals of quartz and pink felspar from the eurite are found completely surrounded by the dark andesite. Thus a pre-existing rock comes to include crystals derived from one that has subsequently invaded it, and hand specimens, apart from study in the field, would be of a most misleading character.—Sir Howard Grubb read a paper on a new form of equatorial mounting for monster reflecting telescopes, observing that as our neighbours in France intend constructing a 3-metre reflector for the Paris Exhibition of 1900, this may not be an inappropriate time to discuss the question of mounting reflecting telescopes of monster sizes, *i.e.* of 8 or 10 feet diameter. The problem to be solved is that of mounting, on an equatorial movement, a telescope of, say, 80 or 100 tons weight, so perfectly equipoised and relieved of friction that it can be conveniently manipulated and carried by clock-work, or some motive power, to follow a celestial object with such accuracy that it will not at any moment vary from its correct position by a quantity equal to the apparent motion of that object in a space of one-tenth or one-twentieth part of a second. To effect this the author proposes to develop further a

system already adopted by Dr. Common, viz. the flotation of the polar axis of the telescope. This is done by making a tube for the Newtonian reflecting telescope (which is necessarily closed at the lower end) of such a weight, and with its weight so distributed that it will not only float in water at a certain point (preferably near the upper end), but will be in a state of equilibrium when placed at any position down to a certain angle, say to within 20° of the horizon, the angle depending on the exact outside form of the tube. With a pair of trunnions attached at the water-line, an 80-ton telescope could be mounted and carried by an equatorial without throwing any weight whatever on that equatorial, the force necessary to drive the instrument being dependent only on the friction to be overcome in carrying the tube at an exceedingly slow rate through the water.

PARIS.

Academy of Sciences, March 12.—M. Lœwy in the chair.—Observations of the new planet BB (Charlois), made at the Paris Observatory, by MM. O. Callandreau and G. Bigourdan.—Preparation and properties of boron carbide, by M. Henri Moissan. Several methods are given for the preparation of this compound at the high temperatures of the electric arc. Clearly-defined crystals of CB_6 are obtained by heating the requisite quantities of carbon and boron with about twice their weight of copper in the electric furnace for six or seven minutes. After solution of the copper and extraction of a little graphite, the residue has a density of 2·51, and is hard enough to polish diamond. The properties of this compound are given at length.—On the reproductive organs of *Ancylus fluviatilis*, by M. de Lacaze-Duthiers.—On the internal pressure of fluids and the form of the function $\phi(pvt) = O$, by M. E. H. Amagat. The author takes the general form $(p + \pi)(v - a) = RT$, hence develops the formula $\left(p + T\frac{dp}{dt} - p\right)(v - a) = RT$, in which $\frac{dp}{dt}(v - a) = R$, whence the values of a for a series of volumes are calculated. These values may be represented by the expression $a_v = \alpha + B(v - \alpha)^n$ where $B = 0{\cdot}0077$, $n = \frac{1}{2}$, and $\alpha = 0{\cdot}0004$. But, from the variation of π (the internal pressure) with the volume, we have $\pi = A\frac{v - \epsilon}{v^m}$; for hydrogen $A = 0{\cdot}000506$, $m = 3$, and $\epsilon = 0{\cdot}002111$. With these values of the arbitrary constants the formula

$$\left(p + A\frac{v - \epsilon}{v^m}\right)(v - [\alpha + B(v - \alpha)^n]) = RT$$

gives for hydrogen values for the pressure calculated from the volume agreeing well with the actual pressures from 100 to 2800 atmospheres. The calculated interior pressure for unit volume at zero temperature and normal pressure is 0·000875 atmos. Kelvin and Joule's experiments make the value 0·0008 atmos.—Magnetic observations in Madagascar in 1892, by P. E. Colin.—On the presence of a polymorphous microbe in syphilis, by Dr. Golasz. The author gives evidence of the existence in the blood of syphilitic patients of a polymorphous bacillus belonging to a species nearly related to Leptothrix and Cladothrix, and hence similar to the species found in cases of tuberculosis, leprosy, and glanders.—On the triangle of sequences. An abstract of a memoir by M. Désiré André.—Observations of the new planets AX (Wolf, March 1) and AZ (Courty, March 5) made at Lyons Observatory, by M. G. Le Cadet.—Observation of the planet 1894 AZ, made with the great equatorial of the Bordeaux Observatory, by M. L. Picart.—Observations of planets, made at the Toulouse Observatory (Brunner equatorial), by M. F. Rossard.—Solar phenomena observed during the third and fourth quarters of 1893, at the observatory of the Roman College. A letter from M. P. Tacchini.—On the capillary depression of the barometer, by M. C. Maltézos. A mathematical investigation resulting in the expression of the opinion that the practical comparison method must still be relied on for correcting barometric heights for capillarity.—Achromatism and chromatism of interference fringes, by M. J. Macé de Lépinay.—Use of electricity for following the phases of certain chemical reactions, by M. Jules Garnier.—A contribution to the study of ferments, by MM. P. Hautefeuille and A. Perrey.—On the spark spectra of some minerals, by M. A. de Gramont. The mineral sulphides, selenides, and tellurides, and native gold, silver, copper, bismuth, arsenic, and antimony have been studied.—Influence of time on the absorption of carbon monoxide by the blood, by M. N. Gréhant.—On the prostatic utriculus and the vasa deferentia in the cetacæ, by MM. H. Beauregard and R. Boulart.—On composite ascidians of the genus *Distaplia*, by M. Caullery.—On ears of maize attacked by *Alucite des cereales* in Central France, by M. A. Laboulbène.—Influence of potassium salts on nitrification, by MM. J. Dumont and J. Crochetelle.—On the fertility of the giant *Persicaire* (*Polygonum sachalinense*), by M. Ch. Baltet.—Physiological researches on fungi, by M. Pierre Lesage.—On the fossil *Cedroxylon varolense*. A note by MM. B. Renault and A. Roche.—On the variation of the composition of the water of lakes with the depth and according to the seasons, by M. A. Delebecque.—On the temperature of caverns, by M. E. A. Martel.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Statesman's Year-Book, 1894 (Macmillan).—A Handbook of Gold-Milling: H. Louis (Macmillan).—The Handbook of Jamaica for 1894 (Stanford).—Ueber die Spectren der Elemente: H. Kayser and C. Runge (Berlin, Reimer).—Deutsche Ueberseeische Meteorologische Beobachtungen, Heft vi. (Berlin).—Construction et Resistance des Machines a Vapeur: Alheilig (Paris, Gauthier-Villars).—Machines Frigorifiques a Air: R. E. de Marchena (Paris, Gauthier-Villars).—Popular Lectures and Addresses: Lord Kelvin, Vol. 2, Geology and General Physics (Macmillan).—A Treatise on Hydrostatics: Prof. A. G Greenhill (Macmillan).—Methods of Pathological Histology: Prof. C. von Kahlden, translated and edited by Dr. H. M. Fletcher (Macmillan).

PAMPHLETS.—Return of Mineral Production in India for 1892 (Simla).—River Temperature, Part 1: H. B. Guppy.—The Aerial Oxidation of Terpenes and Essential Oils: C. T. Kingzett.—Quelques Conclusions et Applications de l'Anthropologie (Paris, Masson).

SERIALS.—Bulletin of the Natural History Society of New Brunswick, No. 11 (St. John, N.B.).—Journal of the Chemical Society, March (Gurney and Jackson). Insect Life. Vol. 6, No. 3 (Washington).—Rendiconto dell' Accademia delle Scienze Fisiche e Matematiche, serie 2ª, Vol. 8, fasc. 1°, e 2° (Napoli).—Economic Journal, March (Macmillan).—Journal of the Institution of Electrical Engineers, No. 109, Vol. xxiii. (Spon).—American Naturalist, March (Philadelphia).—Royal Natural History, Vol. 1. Part 5 (Warne).—Proceedings of the Indiana Academy of Sciences, 1892 (Brookville, Ind.).

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