THURSDAY, JANUARY 3, 1918.

ELECTRICAL ENGINEERING.

(1) *A Treatise on the Elements of Electrical Engineering.* A Text-book for Colleges and Technical Schools. By William S. Franklin. Vol. i., *Direct- and Alternating-current Machines and Systems.* Pp. x+465. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1917.) Price 24*s.* net.

(2) *Continuous-current Motors and Control Apparatus.* A Practical Book for all Classes of Technical Reader. By W. Perren Maycock. Pp. xvi+331. (London: Whittaker and Co., 1917.) Price 6*s.* net.

(3) *Power Wiring Diagrams.* A Handbook of Connection Diagrams of Control and Protective Systems for Industrial Plants. By A. T. Dover. Pp. xv+208. (London: Whittaker and Co., 1917.) Price 6*s.* net.

(1) IT is usual for writers of books on electrical engineering to confine themselves to the theory either of direct-current or of alternating-current practice. In an elementary treatise, however, it is best to include both, and this the author has done. A most satisfactory feature is the introduction of the concepts of the modern theory of electrons, and this greatly stimulates the interest of the reader in many of the phenomena and apparatus described. Other excellent features are a free use of the calculus—we were impressed by the pains taken to make the mathematics simple—and the introduction of many easy problems.

After the table of contents, Prof. Franklin gives a list of the national organisations and societies in America relating to engineering, and describes the field in which each society is specially interested. The student is encouraged to obtain further information directly from the secretaries of these societies. In particular, he is advised to write to the Bureau of Standards at Washington to obtain a list of its publications and full information about its activities. This is very properly regarded as an essential part of the education of an American engineer.

In the first few chapters a *résumé* is given of magnetism and electrodynamics. In several places the author has abbreviated his explanations until they are obscure. We read, for example, on p. 73 that when a circuit has a certain inductance "one volt will cause the current in the circuit to increase at the rate of one ampere per second." The uninitiated reader would naturally think that the current goes on continually increasing so long as the volt is applied in the same way as the velocity of a mass of one gram goes on continually increasing when a dyne is applied to it.

The author is hampered by his loyal adherence to the nomenclature list published by the American Institute of Electrical Engineers. For instance, he calls the unit of the flux of magnetic induction the maxwell, and the unit of magnetic induction density the gauss. We deduce also that a gauss is both a gilbert per centimetre and a maxwell per square centimetre. It seems to us that there is a quite unnecessary dragging in of the names of great men of science, especially as the definitions are framed on the assumption that permeability is a simple numeric. Clerk Maxwell would not have admitted this assumption. The American gauss is the unit both of magnetic induction and of magnetic force. Many physicists consider that magnetic induction is caused by magnetic force just as strain is caused by stress. The assumption that cause and effect are measured in the same unit is unjustifiable.

In our opinion the practice of christening units after the names of men of science should be adopted only very sparingly. The watt and the joule are well named, but we deprecate the growing use of the kelvin for the unit in which electrical energy is bought and sold. Those evil-sounding words, also, the abohm, the abampere, and the abfarad, used by Americans are almost libellous to the great men whose memory they are supposed to keep green.

On p. 96 a table of sparking distances is given between spherical electrodes the diameters of which are 0·5, 1, 2, and 5 cm. respectively. The room temperature at which the experiments were made was 18° C., and the reading of the barometer 745 mm. Analysing the figures given, we find that for a given pair of electrodes the spark occurs very approximately when the maximum potential gradient between them attains a certain definite value. Surely the author should have pointed this out. It is a physical fact of great interest and may well prove to be the starting point of new advances in our knowledge. It is at least of practical value to be able to calculate the sparking distances between spheres and the voltages at which the brush discharges begin to appear on them.

The chapter on the electron theory is clearly written, and much knowledge is given in little compass. We are sorry that Peek's formula for the voltage at which the corona appears on cylindrical wires is not given, as it is wonderfully accurate and most useful to power engineers. Descriptions are given of Cottrell's apparatus for precipitating dust and smoke particles from the atmosphere, and of ozonisers for converting oxygen into ozone. But the most interesting devices described are the vacuum-tube current valves the action of which depends on the emission of electrons by hot bodies. These current valves are now much used as receivers and detectors in radiotelegraphy, and also as "amplifiers" either for exciting or for maintaining electric oscillations.

In those parts of the book devoted more particularly to engineering the author describes the latest types of electrical machines, and it is satisfactory to notice how well they illustrate fundamental principles, and how amenable their theory is to elementary mathematical treatment. The series parallel controller, the rotary converter, the frequency transformer, and all the various types of polyphase motor are cases in point. Some of the proofs given are worthy of high commendation and will be much appreciated by students.

(2) A simple description is given of the various kinds of direct-current motors which are in everyday use, and the elementary theory of their action is explained. The problems which interest the designer are barely mentioned, but the practical methods of testing and the requisite calculations are fully described. The wiring connections are given in far greater detail than in ordinary treatises, and this will be of value to working engineers, enabling them to get a thorough grasp of the requisite connections for the electrical devices which they have to use constantly. Many numerical examples are given. We can recommend this book to the beginner and to all who wish to understand the working of electric starters, controllers, contactors, automatic lifts, etc. The book is well printed, the diagrams are clear, and the machinery and devices described are of the latest types.

(3) The author clearly indicates the scope of his book by describing it as a handbook of connection diagrams of control and protective systems for industrial plants. Considering the limited space at his disposal and the very complicated direct- and alternating-current systems that have to be described, the author has, on the whole, been successful. The reviewer would have liked fuller explanations in places, and some of the diagrams fatigue the eyes. As a book for occasional reference it will prove useful. We notice that in accordance with the practice of many engineers a zigzag line is used to denote an inductive coil. A helical line, however, is more self-explanatory and practically as easy to draw, and we have good hopes that it will soon be universally used. Recommendations to this effect have frequently been made by "symbols" committees in many countries.

A. RUSSELL.

GEODETIC BASE MEASUREMENTS.

La Mesure Rapide des Bases Géodésiques. Par J.-René Benoit et Ch.-Ed. Guillaume. Cinquième édition. Pp. 285. (Paris: Gauthier-Villars et Cie, 1917.)

THE use of invar wires in the measurement of bases in geodetic triangulation, as well as in topographical surveys, has become so well established that a new edition of MM. Benoit and Guillaume's handbook on their employment will be welcomed.

The fifth edition does not for the most part differ greatly from the previous edition, which appeared in 1908, but an additional chapter has been added, in which the results of later experience have been added. The control of the wires, both by fixed marks laid down in a building with which the length of each wire may be compared, and by a short base on which the wires can be used under field conditions, is discussed. The former is in use in England, France, Egypt, India, and elsewhere, while at Potsdam a 240-metre base is used. The permanence of mural control-marks is considered, and the experience of the Bureau at Bréteuil shows that the distance between such points of reference should be verified over a considerable period of time.

The results of base measurements at the Simplon tunnel in 1906, in Uganda in 1907, in Portuguese East Africa, the Argentine, Russia, Mexico, and Rumania are given in some detail, as being operations for which the wires were verified at the Bureau; but these by no means exhaust the list of countries in which the method of measurement by means of wires, initiated by Prof. Jäderin, of Stockholm, in 1890, has been employed. In 1913 a base eight and a half kilometres long was measured near Lyon by the Geographical Service of the Army both with invar wires and with an invar 4-m. bar, in which the mean values obtained by to-and-fro measurements with the bar and those of two wires differed only by 8·3 mm.

The need for comparison between the "bases murales" or the control-marks which now exist in several countries is insisted on, and such a comparison between Bréteuil and Teddington had been taken in hand recently, but has been interrupted by the war. The results of investigations, which were undertaken on the proposal of Sir David Gill, to ascertain the changes caused in a wire by constant use at normal tension are set out; and the results of the comparison made with twelve wires from four to six times yearly over the period 1908 to 1916 in continuation of an earlier series, 1904 to 1907, show well the stability of these wires when carefully handled under favourable conditions.

Three notes on the expansion of invar and the effect of mechanical and thermal treatment upon it conclude this very useful handbook on the use of these wires in field measurement, and the precision which may be attained with them.

More can be said regarding the practical use of these wires in the field and the various difficulties that have from time to time been encountered; but as these lie outside the personal experience of the authors they have not been specially dealt with in this volume.

H. G. L.

PHILOSOPHY.

A Defence of Idealism: Some Questions and Conclusions. By May Sinclair. Pp. xxi+396. (London: Macmillan and Co., Ltd., 1917.) Price 12s. net.

MISS MAY SINCLAIR'S "Defence of Idealism" is written with a most refreshing ease and freedom from technicality. It is the work of an amateur, but of an amateur who has read much and sees how arguments that are usually thought to be abstruse bear closely upon problems which should command the interest of every thinking person. Professional students cannot fail to regard such a book as a gratifying proof of the vitality of philosophy in this country.

The idealism which Miss Sinclair sets out to defend is not idealism in general, but idealistic monism. It would have been well if Miss Sinclair had said plainly what she understands by this doctrine, and how precisely it differs from other "isms" to which Miss Sinclair is opposed. Sometimes she speaks as though the enemy were the New Realism, sometimes Pluralism, sometimes Pragmatism, sometimes something else. To be definite is not to be dull, necessarily; it would not have detracted from the readableness of Miss Sinclair's book if she had made plainer just why she disagrees with William James, M. Bergson, and Mr. Bertrand Russell, to mention three of the contemporary names which figure most frequently in her pages. However, let us take the book as we find it. To a vague and there-or-thereabouts doctrine one can offer nothing but a criticism correspondingly inexact.

It is manifest that Miss Sinclair is, above all, anxious to safeguard the higher elements of our world, the reality of moral experience, the reality of religious experience, and our hope of existence in a future state. Miss Sinclair holds that these valuable elements are gravely threatened both by Pragmatism and by the New Realism. In her quarrel with the New Realists the present reviewer would not wish to intervene. Frankly, he has never been able to understand the logical basis of the New Realism, nor what bearing (if any) that doctrine has upon the vital problems which thoughtful people expect philosophy to illuminate. But in regard to Pragmatism Miss Sinclair seems to have gone gravely astray. The basis of the Pragmatist's belief is a kind of optimism, or, to speak more accurately, a kind of meliorism—that is, a belief that the constitution of the world is good upon the whole; and this implies that the world is such that the higher needs of man's nature are sure to receive satisfaction. If the analysis of human nature goes to show that man needs assurance of the reality of moral and religious experience, and needs belief in a life after death, then that is *pro tanto* a reason for holding that the universe will satisfy those needs. Is this illogical, as Miss Sinclair seems to think? If so, where is the flaw in it? It is quite a mistake for Miss Sinclair to think that "Pragmatism has no logic," and that "it is spineless." On the contrary, it has all the logic that is worth having.

OUR BOOKSHELF.

An Ethical System Based on the Laws of Nature. By M. Deshumbert. Translated from the French by Dr. L. Giles. With a preface by Dr. C. W. Saleeby. Pp. ix+231. (Chicago and London: The Open Court Publishing Co., 1917.) Price 2*s.* 6*d.* net.

HUXLEY maintained that ethical progress depends, not on imitating the cosmic process, but on combating it. M. Deshumbert proclaims a not less exaggerated theory that the whole duty of Man is to bring his conduct into harmony with Nature. Organisms are rich in adaptations which secure self-preservation and the perpetuation of the species; and if man is to continue to survive, he must become increasingly fit in these directions. Organic Nature, historically regarded, shows, on the whole, a progressive differentiation and integration of the nervous system; and man must follow this trend. But among animals it is often clear that success has rewarded not merely strength or cunning, but sociality and care for the offspring as well; and Man must vie with Nature in parental care and mutual aid.

This is familiar good sense, well worth restating in the author's picturesque way, with a pleasant *note personnel*; but we cannot pretend to see any stability in the thesis that "the Good is everything that contributes to the harmonious expansion of the individual and of the groups of which he is a member." For the "harmonious expansion" includes, for man, goodness; and one of the evidences of an evolutionary process being progressive or integrative is just that it leads on to the good. The author seems to wander round in a circle; but it is not a dull circle. His book contains an interesting collection of examples (not always quite accurate) of self-preservative adaptations and parental care; and quite a feature is made of what the Rev. J. G. Wood once gathered together in a suggestive volume—anticipations of man's devices by animals.

Much salutary counsel, sometimes a bit prosaic, is given, by attending to which the sum of human happiness and effectiveness would be greatly increased. It is obvious that man may strengthen his hands and avoid many gratuitous hindrances by regulating his life biologically or physiologically, but we should not call this an ethical system. The book has appeared in at least seven languages—and it cannot but be useful practically. But it does not rise to its title.

The Munition Workers' Handbook. By Ernest Pull. Second edition. Pp. 158. (London: Crosby Lockwood and Son, 1917.) Price 2*s.* 6*d.* net.

THIS little book opens with a brief treatment of workshop arithmetic, mensuration, and geometry, presented in a simple manner suitable for those who have taken up munition work temporarily, and probably forgotten, through disuse, most of the mathematics acquired at school. The composition, mode of manufacture, and strength of iron, steel, and other common materials are then explained. This section of the book should certainly encourage the worker to take a more intelligent interest in workshop processes. Illustrated descriptions of workshop tools are then given, including a good account of the use of micrometers. This section of the book should prove very useful. The following chapters are devoted to workshop operations, such as lathe work, drilling, tapping, screwing, bench work, planing, shaping, milling, and gear-cutting. The author clearly has intimate knowledge both of the subjects dealt with and of the requirements and limitations of the class of worker addressed, and has been successful in producing a book well adapted for the purpose in view. Its merits are such as to lead us to believe that the book will outlast the special conditions created by the war.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Magnetic Storm and Aurora, December 16-17.

THE following details of a noteworthy magnetic storm and aurora, which occurred on December 16–17, are communicated by permission of the Director of the Meteorological Office. C. CHREE.

Kew Observatory, Richmond.

ON the magnetic traces at Kew Observatory, Richmond, Surrey, there were indications of disturbance shortly after 8h. on December 16, but no striking movements until after 14h. (2 p.m.). Activity was greatest between 16h. and midnight of December 16, but some considerable movements appeared after midnight, and the disturbance did not die down until after 4h. on December 17. The range of declination (D) was about 34′, the ranges of horizontal force (H) and vertical force (V) being respectively about 400 γ and 250 γ. The needle reached its extreme westerly position about 14h. 40m., and its extreme easterly position just after 21h. Its largest continuous movement was a swing of 23′ to the west, occupying about thirty-five minutes, and ending just after 22h. The highest and lowest values of H occurred about 17h. and 21h. 15m. respectively; between these hours there was a general tendency to fall. A very rapid movement in H ended just before 21h. 15m., the element falling 215 γ in less than ten minutes. Between the end of this movement and 2h. 25m. on December 17, H rose almost 350 γ.

From 14h. 30m. until after 21h. on December 16 the D trace showed, superposed on a gradual drift to the east, a series of oscillations with a mean period of about twenty-two minutes. The H trace also showed a series of oscillations between 15h. and 18h., and the oscillations in the two elements were roughly in phase, increase in H going with westerly movement of the needle. The changes in V were of a normal kind, the value of the element being raised between 15h. and 22h. on December 16, and depressed in the early hours of December 17. The V trace was almost free from short-period oscillations, and these were also less conspicuous in the D and H traces than is usual with so large a disturbance.

The following particulars are reported from Eskdalemuir Observatory, Dumfriesshire, where the magnetographs record the north (N), west (W), and vertical (V) components of magnetic force:—

Time of commencement 8h. 17m. G.M.T. on December 16.

		h. m.	Range
Maximum of N	at	17 23	638 γ
Minimum ,,	,,	21 27	
Maximum of W	,,	17 16	587 γ
Minimum ,,	,,	21 14	
Maximum of V	between	17 20	>579 γ
	and	17 35	
Minimum ,,	at	21 18	

These ranges, it will be noticed, especially that in V, are much larger than those recorded at Kew Observatory.

After the occurrence of the minimum values about 21h. 20m., the Eskdalemuir curves showed a recovery to about their normal positions; but just before 2h. on December 17 another disturbance was recorded, causing an increase in W and fall in N and V, the changes of force being approximately in N − 150 γ, in W + 80 γ, in V − 260 γ.

Observations of aurora on December 16 have been reported from many stations in Scotland and Ireland. At Eskdalemuir aurora was first noticed at 20⅔h., when it appeared as a glow to W.N.W. At 21h. an arc extended from about N.W. to about N.E., with green streamers extending towards the zenith. At 21h. 10m. the arc had disappeared, but the whole northern half of the sky up to the zenith was glowing brightly. At 21¼h. the glow was less extensive. It was noticed at this time that the streamers radiated to a point about 10° from the zenith towards the south (*i.e.* the radiant point had an elevation of about 80°, an azimuth of about 180°). The streamers were not thin and sharply defined, as is usually the case, but vaguely defined patches of light which glowed brightly. At 21½h. the principal glow was to the W. and W.S.W., but it was also plain to the N.W., N., and N.E. The natural inference was that the centre of the arc of the horizon from which the disturbance proceeded had changed azimuth from N (nearly) to W (nearly) between 21¼h. and 21½h., but the radiant point of the streamers did not change appreciably in position. A slight glow was still visible in the N.E. at 23h.

At Aberdeen Observatory, Mr. Clarke, the observer, reported a fine auroral display on December 16. From 16h. 45m. to 21h. it was of a comparatively stable character. Until 18h. there was a single curtain-arc, with crimson, yellow, and green colouring. Between 18h. and 21h. there were several similar arcs, coloured from yellowish-green to bluish-white. After 21h. the type altered, streamers appearing all over the sky, accompanied by a corona. This second auroral phase would seem to have synchronised with the very rapid fall of magnetic horizontal force at Richmond.

At Rothesay, according to the observer, Mr. J. Davidson, the aurora was very fine indeed. Along with extra long streamers were waves of red and white light, the whole centring overhead and forming an immense "dome" (corona), where both streamers and waves of light centred. The red waves came mostly from N.W. and N.E.

At Fort Augustus the "dome" was in the zenith at 21h. 15m. The most southerly station from which observations have been received at present is Seskin, near Waterford, where the aurora was "moderately bright" at 21h., and "faint" at 22h. The observer, Mr. Ernest Grubb, writes:—"The aurora on Sunday was much brighter at Mount Mellick, fifty-seven miles north of here, and very much brighter at Belfast, 174 miles north of here."

At Southport "a very fine display of streamers" was seen early on December 17, between 2½h. and 2¾h., and therefore corresponded with the second magnetic disturbance at Eskdalemuir.

SOURCES OF POTASH.

AS is well known, the world's supply of potash during the last three years has been greatly curtailed owing to the present isolation of Germany, and compounds of potassium have, consequently, greatly increased in price. This, of course, has acted adversely on the interests of agriculture, of medicine, and of numberless processes in the arts which are more or less dependent upon the use of potash compounds. Up to within comparatively recent times such potash as the world needed was obtained from sea-water, either directly, or indirectly through the medium of sea-plants (*kelp* or *varec*); by the incineration of land-plants (wood-ashes); from *vinasse*, or the residue left on distilling fermented beetroot molasses; from *suint*, or the "yolk" of sheep's wool, etc. These still continue to be sources of potash, but they are of comparatively subordinate importance when compared with the relatively enormous output of the Stassfurt deposits. All these sources, including those of the Stassfurt beds, are ultimately dependent on the primitive rocks of the earth—that is, to the decomposition of such minerals as potash felspar, potash mica, and the vast number of zeolites and other silicates which make up much of the rock-forming material.

Felspars are, in fact, the most abundant minerals in the earth's crust, constituting, according to Dr. Hatch, about 48 per cent. of the whole, the potash felspars forming the predominant proportion. Orthoclase, when pure, should contain 16·9 per cent. of potash (K_2O), but such a theoretical figure is never reached, owing to a greater or less admixture of soda. About 12 per cent. of potash is the usual amount, which is rather more than the average percentage in the Stassfurt deposits. Many suggestions have been made from time to time to extract the potash from the two chief varieties of potash-felspar, viz. orthoclase and microcline, and from the intrusive igneous rock known as pegmatite, which is a mixture of quartz and felspar; and a large number of patented processes for this purpose are on record. It is said that upwards of one hundred patents on this subject have been taken out in the United States alone. One of the most promising of these was that of E. Bassett, who, in 1913, patented in the United States and Canada a process based on the discovery that powdered potash-felspar, when fritted with common salt, was decomposed, with the formation of potassium chloride, which could be leached out from the sintered material, and obtained sufficiently pure for technical purposes by fractional crystallisation.

This process was independently discovered, and has been carefully studied, by Mr. E. A. Ashcroft, who has brought it to the notice of the Institution of Mining and Metallurgy in a paper which has just been published (Bulletin No. 159, December 13, 1917). The reaction is a reversible one, and for its success in affording the maximum yield of potash certain conditions of fineness, temperature, duration of heating, and absence of air and moisture must be observed, which, however, would seem to be easily reached in practice. Large deposits of suitable material are to be met with in Great Britain, notably in Cornwall and in various parts of Scotland and Wales. Other localities occur in Ireland. Some of these are already worked for pottery purposes, but others, as in Sutherlandshire, on the extreme north-west coast of Scotland, are untouched, and would be eminently suitable sources of supply, and capable of yielding some 20,000,000 tons of material without going below visible outcrops.

Considerations of space prevent any fuller analysis of Mr. Ashcroft's proposals, but we are inclined to concur in his general conclusion that from a purely commercial point of view the attempt to work these Scottish deposits seems fully justified as likely to prove remunerative, and we further agree with his contention that, given the raw material of the potash trade (the chloride), manures and all other potash products can be produced at least as favourably in this country as in Germany, and that an important section of German trade may thus be wrested from her, whilst our own urgent needs for munitions of war, for the soil, and for the chemical industries may be supplied.

The Stassfurt deposits occupy an extensive basin in the North German Plain, in Prussian Saxony, close to the borders of Anhalt. The brine-springs which they furnish have been known and intermittently worked since the early part of the thirteenth century, but they ceased to be remunerative, as sources of common salt, in the first years of the nineteenth century, and their working was abandoned. In 1839 the Prussian Mining Office commenced a systematic examination of these deposits, and put down a number of borings in different parts of the area, with the result that the potash formations were found to occur in practically only one locality, near the River Bode, not far from Magdeburg. During the last third of the preceding century a new industry sprang up and the villages of Stassfurt and Leopoldshall, from being wholly insignificant places, became the centres of a numerous population.

The conditions under which the Stassfurt deposits have been formed were the subject of elaborate inquiry by van't Hoff and his coadjutors so long as the eminent Dutch chemist lived. Although his interpretation cannot be said to be wholly satisfactory, the investigation greatly elucidated the mode in which the beds are supposed to occur, and rendered it very probable that similar deposits will be found in other parts of the world. Indeed, their existence has already been proved. In 1909 large deposits of sylvine, or potassium chloride, were discovered in Upper Alsace, in an area of about 200 sq. km., near Mulhouse. Two strata were found, the upper 3 ft. thick, the lower more than 16 ft. thick at a depth of from 1600 ft. to 2100 ft. This field, unlike that of North Germany, seems to be continuous, without faults, and is of more recent geological origin.[1]

The issue of *La Nature* for November 24 contains an interesting account of what has been allowed to transpire concerning these Alsatian beds, from which the following particulars are taken. The deposits, although continuous, are far from being horizontal or uniform. On the contrary, they are folded and irregular. The lower layer of sylvine is surrounded and covered, throughout the whole of its extent, by the upper layer, arranged somewhat in the form of an ellipse, in plan not unlike, indeed, a painter's palette. At the edges the saline layers gradually thin out and disappear. From their great depth they are naturally at a high temperature, not less than 48° C. From statements made in 1912 it was calculated that the upper layer of

[1] Cf. Prof. Lunge in Thorpe's "Dictionary of Applied Chemistry."

sylvine contained about 98,000,000 cubic metres, distributed over 84,000,000 square metres, whereas the lower layer amounted to 603,000,000 cubic metres, spread over an area of 172,000,000 square metres, equivalent in round numbers to 1,500,000,000 tons of potassium salts, or 300,000,000 tons of pure potash. The first borings were made at Wittelsheim (originally in 1904, in searching for coal), and some fourteen others have been made over different parts of the area. The salt began to be won in 1910, and in 1912, from the Amelia mine, with 200 men, the daily output reached 300 tons. The mineral, brought to bank, was crushed and powdered and either treated directly for the manufacture of "muriate" or exported.

The potash layers are composed of bands, alternately red and grey, consisting principally of a mixture of sylvine and rock-salt. The red bands, coloured with ferric oxide, contain the principal amount of the potash salt, whereas the grey consist mainly of common salt. In addition there are found thin layers of argillaceous schist and anhydrite. The content of potassium chloride varies from 20 to 68 per cent., and rarely falls as low as 10 per cent. The raw products contain only insignificant quantities of magnesium salts and may, therefore, be used directly in agriculture after grinding. In this respect they are more advantageous than the Stassfurt salts, which need separation from the large quantities of associated magnesium salts. The Reichweiler factory is capable of treating daily about 260 tons of the raw mineral, producing from 40 to 50 tons of pure potassium chloride. The content of bromine is so small as not to be worth extraction.

The production of Alsatian potash is carefully regulated by the German Government, and by the law of May 25, 1910, the Amelia mine, the only one actually at work in Alsace, was allowed to produce no more than 1·46 per cent. of the total yield of the Empire, *i.e.* 9000 tons of pure potash, or 45,000 tons of raw salt, corresponding with an extraction of fifteen wagons per diem, far below what it was capable of affording. At the beginning of the war, in spite of some improvement in the situation, the fifteen Alsatian mines, capable of yielding in the aggregate about 800,000 tons per annum, were allowed to sell only 80,000 tons, and the total amount reserved to Alsace was permitted to be only about one-tenth of the German production. This action is, of course, due to the attempts of the German authorities to control and strengthen the monopoly they practically possess—a condition which would be altogether modified by the return of Alsace to France, and by the *rôle* which the State mines of Stassfurt might be made to play in the case of a war indemnity by Germany.

Of the other considerable natural deposits which are known to occur, the most important are those of Spain and Abyssinia. The Spanish beds occur at Suria, in Catalonia, and to-day belong to the Solvay Company. They have been found at depths of from 40 m. to 60 m., but certainly extend much deeper. They date probably from the end of the Eocene or the beginning of the Oligocene period and are widely distributed, the potash salts occurring irregularly mixed with rock-salt. The potash compounds consist of carnallite and sylvine in layers of an intense red colour, with alternate reddish layers of common salt. The richest zones appear to follow anticlinal folds running from south to north to Cardona, Suria, and Callus. The area explored is only some 230,000 square metres, but it is said to contain about two and a half million tons of carnallite and nearly a million and a quarter tons of sylvine in local thicknesses of 17 m. of carnallite and 3·75 m. of sylvine. At present these Spanish deposits are not utilised, owing to the influence of Germany on Spanish affairs. The Cortes was offered a Bill in order to promote the working of the mines, but it was opposed by a faction in the interests of Germany, and no result followed. A Royal decree in June, 1915, modified the conditions, but these were still so restrictive that the Solvay Company was prevented from exploiting the mines. On the other hand, certain Spanish corporations, working in concert with the German syndicate at Stassfurt, have obtained concessions in the vicinity of Cardona, and State reservations have been created in the provinces of Barcelona and Lerida; but no further action has been taken, ostensibly on the ground that the Spanish Geological Institute has not yet completed its explorations.

The Abyssinian deposits belong to Italy. They occur in Erythrea, at 90 km. from the coast to the south-east of Massaoua, and at 10 km. to the north of Atel Bad in long. 40°, close to the Italian frontier. Their exploitation has hitherto been very difficult, owing to the hostility of the Abyssinians. These conditions are now notably improved, partly by a more effective possession by the Italians, and partly by recent changes in the Government of Abyssinia, which is more favourably disposed towards the Allies. The deposits already furnish about 20,000 tons per annum. Not much is known concerning their physical characteristics or the conditions of their formation, but they are certainly much more recent than those of Alsace and Spain, which are Tertiary; they have probably been formed by the comparatively recent evaporation of an ancient arm of the sea running north and south, due to one of the great lines of rupture extending from Palestine and traversing the whole of the east of Africa along a region still of volcanic activity.

Conditions such as probably have produced the Stassfurt deposits are still at work and may be observed in several parts of the world operating over large areas, as, for example, in the Adji-Darja Bay, in the east of the Caspian Sea—a bay 2000 to 3000 square miles in extent, and almost entirely shut off from the Caspian by a bar. There is here a continuous separation of salt, estimated by Schleiden to be about 400,000 tons per diem, with an outflow of dense mother-liquor back to the Caspian, except where it sinks in the deeper parts of the bay, when the mother-liquor salts are gradually deposited. None of these areas has been investigated with such care as that of the North German Plain, but the general conditions which have led to their production are seen to be similar, although local circumstances, especially the extent to which they were subjected to an intermittent influx of sea-water, have modified the nature, relative amounts, and distribution of their various saline constituents. T. E. THORPE.

NATIONAL POWER SUPPLY.[1]

THE interim report issued by the Coal Conservation Sub-committee presided over by Lord Haldane will be read with great interest, as it crystallises the considered opinions of eminent engineers. The committee has little difficulty in proving that the present system of electrical power distribution in this country is most uneconomical. If it had all to be done *de novo* the Committee would divide the country into some sixteen districts. In each district there would be several large inter-connected super-stations for generating electric power, and these would be controlled by a single authority. The sites of these stations would not be chosen, as they too often are at present, mainly to secure that the "rates" payable on the electric works may come to the local authority working the undertaking, but they would be chosen on the lines laid down by Kelvin in 1878. They would therefore be either near the pit's mouth, where coal dross could be used for working engines of the most economical type, or in places where plenty of condensing water is available, where coal transport is cheap, and where they would be near the centre of gravity of the probable demand. If this were done it is calculated that as many as 55,000,000 tons of coal would be saved per annum, a saving that would far more than counterbalance the interest payable on the new capital necessary.

We agree with the Committee that it is in the national interest that the change should be made as soon as possible, and we think that the probable saving that would be effected has been somewhat under-estimated. Both Mr. C. H. Merz and Mr. C. P. Sparks, who are members of the Committee, have shown by the stations they have designed the great commercial possibilities of "supply in bulk," and what a boon it is in industrial areas. They are not inviting the country to take any speculative risks—the pioneer work has all been done. Dr. Ferranti, Lord Crawford, and Mr. Ince thoroughly appreciated the main facts of the problems in 1888, when the Deptford power station was first designed.

The Committee is right in saying that the difficulties which stand in the way are "political" rather than "engineering." There are too many vested interests at stake—those of engineers as well as capitalists—to make the course of any national power supply scheme a smooth one. The suggestion of a Board of Electricity Commissioners is a good one, but the powers of the Board will have to be very carefully defined. Everyone will agree that the Board should be empowered to stop the extension or multiplication of uneconomical stations for public supply, and that it should aim at ultimately securing the adoption of a bulk supply scheme somewhat similar to that outlined in the report under notice.

It will be interesting to see how far the conclusions of the report will be endorsed by the Board of Trade Electric Supply Committee, which is at present sitting, and on which municipal engineers are represented. In any event the Sub-committee is to be congratulated on having made excellent and timely suggestions.

[1] Reconstruction Committee: Coal Conservation Sub-committee. Interim Report on Electric Power Supply in Great Britain. Cd. 8880. (London: Imperial House, Kingsway, W.C.2.) Price 3*d*. net.

ECONOMISING SUGAR.

OUR contemporary, *La Nature,* devotes an article in a recent number (December 1) to a consideration of the use of substitutes for sugar, in view of the present shortage of that commodity. Sugar is a foodstuff; but as a nutrient it can be replaced by other carbohydrates, such as those contained in farinaceous foods and vegetables. The essential thing as regards sugar is to find a substitute with sweetening properties. Glucose, obtained by hydrolysing starch with sulphuric acid, is the only sugar other than the ordinary supplies producible in large quantities; but it has a low sweetening power, is not economical, and has reached an almost prohibitive price in France. There remain the sweet chemical products, of which the two chief are dulcin and saccharin. Dulcin, para-ethoxyphenyl urea, is obtained from phenetidine and urea, and has about two hundred times the sweetness of cane-sugar. It has not, however, been much used as a sweetener, since saccharin is cheaper and much more effective. This compound, it may be recalled, has for its parent substance toluene—the coar-tar product which serves also to provide the explosive trinitrotoluene. In making saccharin, toluene is converted first into its sulphochloride and then into the sulphonamide, which is oxidised with potassium permanganate to produce orthosulphamidobenzoic acid. Saccharin is the anhydride, or imido-derivative, of this acid; it is claimed to be about five hundred and fifty times as sweet as cane-sugar. It is not very soluble in water, and is generally employed in the form of its sodium or ammonium salt (sucramine), both of which are readily soluble.

Before the outbreak of war saccharin was chiefly made in Germany, but had been produced in this country to a small extent, and the manufacture has again been taken up here quite recently. In France four factories have lately been equipped to produce it. As regards the raw materials, ordinarily these would be accessible enough and cheap enough, but at present there is, of course, a great demand for toluene, and potassium salts are scarce. Nevertheless, a certain quantity of toluene can presumably be spared for urgent wants, and there is no absolute necessity to use *potassium* permanganate as oxidising agent. In any case the French factories are proceeding with the manufacture, and, as our contemporary observes, *"la pro-*

chaine apparition de la saccharine sera la bienvenue."

The writer of the French article suggests that it might be well, perhaps, to utilise the saccharin solely for mixing with sugar, as is done in Italy. This economises sugar, since a smaller "ration" will suffice, and is better than selling a substance which has no nutritive value at all. Moreover, it would diminish the rather unpleasant after-taste of saccharin used alone, and would also facilitate the employment of certain nourishing foodstuffs, such as cocoa, rice, and farinaceous foods, which require sweetening to make them palatable to most people. A suggestion that saccharin might be therapeutically objectionable is dismissed as of no serious weight, in view of the experience obtained with it in the past.

In this country saccharin has already been employed to a small extent in a somewhat similar manner, namely, to sweeten milk-sugar for sale as a sugar substitute. The supply of milk-sugar, however, is restricted. If our own authorities have not already done so, they might perhaps find it worth while to consider the plan suggested by the French writer. Five hundred pounds of sugar *plus* 1 lb. of saccharin would have about the same sweetening value as 1000 lb. of sugar used alone.

NOTES.

THE trustees of the British Museum have been given notice by the Government that the museum is to be requisitioned as the headquarters of the Air Board. This decision will be received with dismay by everyone who possesses intellectual interests or understands the value of the collections in the galleries of the great building at Bloomsbury. To pack up and store away the many fragile objects in the museum in order to prepare the galleries for occupation means ruin to the specimens, and the ruthless undoing of careful organising work of many years. Sir Arthur Evans, president of the British Association, and one of the trustees of the museum, writes to the *Times* of January 2 to protest against the wanton sacrifice of national treasures involved in the hurried removal of specimens from their cases, or the alternative of letting them remain while the building is used as the headquarters of a combatant department. "Even the bare statement of this proposal," he remarks, "will cause a shudder to run through all civilised countries. Were it carried out it would cover the British nation with lasting obloquy. I write this with the hope that even at the eleventh hour the Government may recoil from a step which could not but provoke a deep and widespread indignation." If the British Museum represented the last extremity in housing the Air Board, the occupation of the building would have to be accepted as an inevitable consequence of conditions of war. We have not, however, reached a degree of national stress which would justify the outrage now contemplated; and we trust that immediate steps will be taken to induce the Government to find a domicile for the Air Board without dismantling our national museum and ruining many of the priceless treasures collected within its walls.

A LONG list of New Year honours was published on Tuesday. Among the names included the following will be familiar to scientific workers:—*K.C.B.* (*Civil Division*): Mr. A. D. Hall, F.R.S., Secretary to the Board of Agriculture; Sir George Newman, Principal Medical Officer to the Board of Education. *C.B.* (*Civil Division*): Mr. F. L. C. Floud, Assistant Secretary to the Board of Agriculture. *Baronet:* Prof. James Ritchie, Irvine professor of bacteriology, University of Edinburgh. *C.I.E.:* Mr. P. H. Clutterbuck, Indian Forest Service, Chief Conservator of Forests, United Provinces. *Knighthoods:* Mr. W. N. Atkinson, who has contributed largely to a knowledge of the dangers of coal-dust in mines; Dr. J. Scott Keltie, editor of "The Statesman's Year-Book," and for many years secretary of the Royal Geographical Society; Dr. A. Macphail, professor of the history of medicine, McGill University, Montreal. In addition a large number of medical men have received honours for services rendered in connection with military operations in the field.

THE report on the production of iron and steel in Canada during the calendar year 1916, which has just been issued by the Canadian Department of Mines, is of exceptional interest at a time like the present, when the preponderating influence of iron output upon the European war is daily becoming more evident. The main outstanding fact is that the production of pig-iron was just above one million statute tons, being an increase of 27·9 per cent. as compared with that of 1915. Only a small proportion, about 10 per cent., of the iron ore smelted was produced in Canada, a little more than half the remainder being Lake ore from the United States, smelted mainly in Ontario, and the rest consisting of Wabane ore from Newfoundland, smelted in Nova Scotia. Thus fully half the ore smelted is of British origin. The total production of iron ore in Canada was only about 250,000 statute tons, approximately one-half of which was smelted within the Dominion and one-half exported to the United States. It is noteworthy that Canada produced in the year in question 28,628 tons of ferro-alloys, including ferro-silicon, ferro-molybdenum, and ferro-phosphorus, smelted in electric furnaces. The total steel production of Canada was 1,428,429 short tons of ingots and castings, being an increase of 40 per cent. above the previous year; of this amount 1,397,703 short tons were ingots, the remainder being castings. Practically all this is open-hearth steel, only 1400 tons of Bessemer steel having been made, whilst about 26,000 tons of steel were made in electric furnaces. The quantity of scrap worked up is quite considerable, amounting to about 47 per cent. of the steel produced and 71·5 per cent. of the pig-iron charged. The increase in production shown all round is very satisfactory, and indicates how energetically Canadian ironmasters have striven to contribute to the Imperial output of this all-important material. There is also a highly significant piece of information, namely, that the production of iron ore in the United States in 1916 was as much as 75½ million statute tons, or an increase of twenty million tons above the 1915 production; seeing that the iron in this increase is by itself nearly equal to the whole iron production of Germany, it is very evident that the part that America can play in the great war is likely to prove a decisive factor before very long.

WE learn with regret that Prof. C. Christiansen, professor of physics in the University of Copenhagen from 1886 to 1912, died on December 28, at seventy-four years of age.

THE *Chemist and Druggist* announces that Dr. M. Louis Martin, head of the Pasteur Hospital at Paris, and Prof. Albert Calmette, director of the Pasteur Institute at Lille, have been unanimously elected subdirectors of the Paris Pasteur Institute in succession to the late Profs. Metchnikoff and Chamberland.

AFTER a succession of shocks, which began early on December 26, Guatemala City was destroyed by an earthquake on Saturday, December 29. It is reported that the whole city is in ruins, and that at least one thousand people have been killed.

MR. E. E. LOWE, honorary secretary of the Museums Association, has been invited by the Ministry of Food to organise and control food economy exhibitions throughout the country. The Leicester Museum and Library Committee has released Mr. Lowe temporarily in order that he may undertake this important national work.

MAORI pictographs have long been known to exist in the limestone caves and rock-shelters of the South Island, New Zealand, but recent examination by an American ethnologist, Dr. Elmore, has proved them to be of unexpected interest. On the suggestion of Dr. Benham, the museums of Wellington and Auckland have joined forces with the Otago Museum, and have removed a number of slabs from the caves for permanent preservation in the three museums.

ON January 2 the Institution of Civil Engineers completed the hundredth year of its existence, having been established in 1818 at a meeting of eight engineers at the Kendal Coffee House in Fleet Street. At the next ordinary meeting of the institution on January 8, before the discussion of papers, a statement commemorative of the founding of the institution will be made, present conditions precluding more formal celebration of the centenary.

MR. T. F. CHEESEMAN, author of the "Manual of the New Zealand Flora," has formed by his own private efforts, extending over forty-five years, a large collection of New Zealand plants. To this the trustees of the British Museum, in recognition of Mr. Cheeseman's valuable help, have recently added a nearly complete set of the plants collected in New Zealand by Banks and Solander (1769–70). The collection and its cabinets now occupy a room 25 ft. long, and Mr. Cheeseman has offered to present the whole to the Auckland Museum, of which he is curator, if that institution will engage to place it in a separate room and maintain it as a public herbarium. Since there is as yet no botanical museum in New Zealand, this offer is certainly one to be accepted.

THE report of the council of the Scottish Meteorological Society, adopted at the general meeting of the society held on December 20, states that the council has continued to keep steadily in view the encouragement of rainfall observation in Scotland, and there are available in the Journal monthly and annual figures for fully 750 stations. Much time has been devoted to tabulating and arranging the great mass of rainfall statistics now available. There are at present 261 members of the society, of whom eighty-one are life members. The council for the ensuing twelve months is constituted as follows:—*President:* Prof. R. A. Sampson; *Vice-Presidents:* Mr. M. M'Callum Fairgrieve and Dr. C. G. Knott; *Council:* Prof. T. Hudson Beare, Dr. J. D. Falconer, Mr. J. Mackay Bernard, Mr. D. A. Stevenson, Mr. R. Cross, Mr. S. B. Hog, Mr. G. Thomson, Dr. A. Crichton Mitchell, and Mr. G. A. Mitchell; *Hon. Secretary:* Dr. E. M. Wedderburn; *Hon. Treasurer:* Mr. W. B. Wilson.

THE last report of the Bristol Museum and Art Gallery describes an excellent scheme for popularising the collections. A large hall capable of accommodating 300–400 wounded soldiers was opened. The men were received by guides, who explained the pictures and exhibits; lantern lectures and demonstrations by members of the staff were organised, and the scheme was supported by the Lord Mayor and other leading citizens. "The keen interest and enthusiasm of the soldiers reacted upon the staff, who found the work a delight, and many men returned on leave-days to continue the studies thus begun."

IN this country we are unfortunately still prone to regard our museums as places of "innocent amusement" rather than as centres of education. It is otherwise in America. There the Natural History Museum, for example, is regarded as an indispensable factor in national well-being, serving both as a centre of instruction to the general public as to the natural resources of the country, and as the repository of the material necessary to those engaged in the development and conservation of such resources. To further these aims the American Museum of Natural History publishes an admirable *Museum Journal,* ably written and most profusely illustrated. The November issue of this journal well demonstrates the range of these activities, for it contains, among other things, a number of exceptionally fine photographs of the bird-life of the Falkland Islands, including nesting colonies of penguins, king-shags, and giant petrels, and two valuable accounts of explorations in New Mexico and the Navaho region. The former deals with the ancient and buried cities of the La Plata region, while the latter describes the customs of the Navaho Indians, incidentally directing attention to cave-dwellings of extinct peoples awaiting investigation.

THE theory that early society was organised on the patriarchal model, popularised by Sir H. Maine in his work on "Ancient Law," was generally accepted until the priority of matrilinear kinship was urged by writers like Bachofen and McLennan. Their view was supported by the investigations into the organisation of the Central Australian tribes by Messrs. Spencer and Gillen. At present among European anthropologists the priority of matrilinear kinship is generally recognised. But two eminent American anthropologists, Dr. Lowie and Dr. Swanton, have questioned its existence among the American Indian tribes. Their conclusions have been criticised in an elaborate paper by Dr. E. Sidney Hartland (Memoirs of the American Anthropological Association, vol. iv., No. 1), in which he proves that in most of these tribes there is evidence of a previous stage of matrilinear organisation, and, where it is wanting, its absence is due to vicissitudes and external influences to which these tribes have been exposed.

UNDER the name of the "Inometer," Prof. T. Johnson, of the Royal College of Science for Ireland, has introduced a new form of food chart, constructed on the principle of the thermometer. The degrees on the scale represent large Calories, and the principal points are placed at 4000 Cal., 3500 Cal., 3000 Cal., 2500 Cal., and 2000 Cal. These represent the food energy (expressed in Calories) requisite for the performance of a day's work, ranging from heavy muscular work at 4000 Cal. to sedentary work at 2500 Cal., the energy expenditure of a man resting in bed being placed at 2000 Cal. In addition, there are interpolated at various points on the scale the numbers of Calories furnished by definite quantities of a variety of common foods, together with their cost in Dublin in April, 1917. The chart is accompanied by eight pages of letterpress, in which is given a clear and simple account of the uses of food, together with suggestions for the making up of dietaries, having regard to both the economic and patriotic aspects of food problems in war-time. The pamphlet is published by the Department of Agriculture and Technical Instruction for Ireland, and can be had free on application.

A SHORT paper by Mr. E. S. Goodrich in the *Quarterly Journal of Microscopical Science* (vol. lxii., part 4) throws considerable light on the interesting problem of the homologies of the cœlomic spaces in various groups of the animal kingdom. The "proboscis pores," which lead from the proboscis cœlom to the exterior in Balanoglossus, are believed to be represented in Echinoderms by the water pore, and in Amphioxus by the opening of Hatschek's pit, as originally suggested by Bateson. But the anterior cœlomic sacs of Amphioxus, one of which becomes metamorphosed into Hatschek's pit, are homologous with the premandibular somites of Craniates. The cavities of these somites may develop a tubular connection with the hypophysis, which is to be identified with the proboscis pore of lower forms, while the hypophysis itself is the homologue of the ciliated "wheel organ" in the buccal cavity of Amphioxus. These views are supported by an interesting reconstruction of part of the head of an embryo torpedo.

IN the Transactions of the Royal Society of South Africa (vol. vi., part 1, 1917) Mr. P. A. Wagner publishes an exhaustive monograph on the national game of skill of Africa. The game, in one form or the other, is played in rows of holes scooped out of the ground, or on wooden, stone, or even ivory boards. As a matter of fact, it is not confined to Africa, being played in Syria, Arabia, Bombay, Ceylon, the Malay Peninsula, and along the entire southern coast of Asia as far as the Philippine Islands. It is essentially a war game, two players, or sides, directing a contest between armies of equal strength, the object being the capture or "killing" of "men," who are represented by small stones, seeds, shells, or fragments of dried cow-dung. It is often played for a stake, but it is certainly not a gambling game, as some writers have maintained. It is also incorrect to say that it is very intricate, though it does require a certain facility in ready reckoning. It is of considerable antiquity, being known to the Arabs of the Middle Ages, and stone boards and fragments of others have been found in the neighbourhood of ancient ruins in Rhodesia. The problem of the methods by which this game appears in such a wide area is interesting, but is not dealt with by Mr. Wagner.

IN a study of the natural regeneration of the Douglas fir and other conifers in the Pacific coast forests of the United States, published in the *Journal of Agricultural Research*, vol. xi., pp. 1–26 (October, 1917), J. V. Hofmann shows that when a large area is either burnt or cut away, the complete restocking which usually takes place does not result from the seeds that are scattered by surviving trees on the area or in its vicinity. The distance from the parent tree to which seed is carried by the wind is very small, 150 to 300 ft. Consequently, if only wind-dispersed seed germinated, the regeneration of a large area would not be completed until after the growth of several generations of trees. The reproduction is never a gradual creeping out from surrounding bodies of green trees, but is a sudden taking possession of the whole area by a dense growth of seedlings. The regeneration is really effected by the seed which is stored in the ground amidst the litter and humus, which are not destroyed in the swift passage of the ordinary forest fire. The litter is found on examination to contain a large number of germinable seed. The ordinary form of succession is the replacement of the forest almost immediately by the same species as composed the original stand, and usually in the same proportions. This paper is well illustrated with diagrams and photographs. One plate is a view of the reproduction on the Yacolt "Burn" of 1902 in the Columbia National Forest. The extent devastated by fire is 604,000 acres. No green trees are visible, yet there are seedlings growing among the snags over the whole area.

PROF. P. L. MERCANTON, in the *Revue générale des Sciences* for November 30 last, discusses the results of the more recent observations on the advance and retreat of glaciers, especially Alpine. Systematic work was begun by Prof. Forel thirty-seven years ago in the Swiss Alps, and for at least thirty of them the movements of the Rhone Glacier and the two at Grindelwald have been carefully noted. Those on the northern side of Mont Blanc have also been studied, and similar work is now being carried on in other icefields. But the main advances and retreats of those glaciers and a few others in the Alps are known for fully three centuries, and estimates of their periods have been attempted. These do not correspond with Wolf's eleven-year period, or with the thirty-five-year one of Brückner. Some causes affect their movements other than the snowfall in the upper region—that of the névé—and the ablation due to temperature changes in the lower; for of two adjacent glaciers, one may be advancing while another is retreating. Recent observations, as Prof. Mercanton points out, indicate that the volume and the length of a glacier can to some extent vary independently, or, in other words, that the ice moves down a valley from the more expanded névé basin at its head, not with perfect uniformity, but with local intermittence, so that a belt near the end may be swelling up in a wide mound, and thus the actual volume of ice be increasing, while the end itself is in retreat. Evidently, as Prof. Mercanton observes, the subject of glaciers and their history is not yet exhausted.

PROF. FILIPPO EREDIA has recently published in the *Bollettino d'Informazione* of the Italian Colonial Office a useful note on the frequency of snow in Tripoli and in Algeria. In the last-named country at sea-level snow is rare, since only one fall in the whole year may be expected. At a height of 600 metres six falls per annum occur on the average, while at double this elevation twenty-five falls are experienced. In Algeria and Tunisia the most frequent and extensive snowfalls occurred in the winter of 1890–91, while 1884, 1904–5, 1913, and 1915 were also characterised by abundant snowfalls. Some interesting photographs are given of snow scenes in Tripoli during the snowstorms of February, 1913, and February, 1915.

AN interesting instance of the way in which the solution of a problem in one branch of science provides or aids in the solution of a problem in an entirely different branch was brought before the Institution of Mechanical Engineers on December 14 by Messrs. Griffith and Taylor in a communication entitled "The Use of Soap Films in Solving Torsion Problems." The authors show that the equations which determine the stress in a rod of any section subjected to twist are identical with those which determine the slope of a soap film formed in a hole of the same shape as the section, in a horizontal plate above which it protrudes owing to a small excess of pressure on the under-side of the film. The slope of the film at any point is found by an optical method, and a number of diagrams of the contour lines for various sections are given. The diagrams thus obtained lead to a general method of calculating the torsional strengths of rods of difficult sections, which gives results much more accurate than those at present in use.

MESSRS. P. L. GAINEY and L. F. Metzler are the authors of an interesting article entitled "Some Factors affecting Nitrate-Nitrogen Accumulation in Soil" in the *Journal of Agricultural Research* (vol. xi., No. 2). The soil employed in the work described was an Oswego silt loam, and some preliminary experiments led to the conclusion that the amount of nitrate produced is independent of the quantity of soil, of its depth (provided the soil was left loose), of the ratio of the exposed surface of the soil to its weight, and of the shape and size of the containing vessel. These points having been determined, experiments were made to ascertain the effect of variations of the depth of column, moisture content, and compactness of the soil upon nitrate accumulation. From the results of these experiments the following conclusions are drawn: First, that the amount of nitrate increases with the compactness of the soil, provided that the latter is not saturated with moisture. Secondly, the optimum moisture content of the soil (with any degree of compactness tested) is approximately two-thirds of the total amount of moisture it will retain, and provided the moisture present does not exceed this optimum, the aeration will be adequate to a depth of one foot, however compact the soil. Thirdly, the accumulation of nitrate increases with increasing depth down to 2 ft. so long as the moisture does not exceed two-thirds saturation. Fourthly, that nitrate accumulates more rapidly in unbroken soil columns than in pulverised soil (in a column of soil uncultivated for seven years aeration was far greater than that required to maintain aerobic conditions). The authors point out that such beneficial effect as cultivating the soil may have upon its biological activity cannot be attributed to increased aeration, because the experimental data available for normal field soils indicate that obligate aerobic conditions almost invariably exist within the first foot of surface.

IN the *Atti dei Lincei*, vol. xxvi. (2), 6, Dr. Quirino Majorana describes an experiment performed with the object of testing whether reflection from a mirror in motion affects the velocity of light. For this purpose a number of mirrors were arranged symmetrically round a rapidly revolving wheel, so that a pencil of light could be reflected from a moving mirror, then from a fixed mirror, then from another moving mirror, the process being repeated any desired number of times so as to increase the effect, and the mirrors having a component velocity in the direction of the ray, and in a sense depending on that of the rotation. The change in the wave-length produced by the rotation was observed by a Michelson interferometer, the object being to ascertain whether this change was or was not the same as would take place if the velocity of light remained constant. Although the limits of error were considerable, it was found that the results led to the conclusion that reflection from a moving mirror does not change the velocity of light relative to the surrounding medium.

MESSRS. C. GRIFFIN AND CO., LTD., are about to publish "Transmission Gears: Mechanical, Electric, and Hydraulic, for Land and Marine Purposes," by E. Butler, and new editions of "Coast Erosion and Protection," by Prof. E. R. Matthews; "Mechanical Engineering for Beginners and Others," by R. S. McLaren, and "Treatise on the Principles and Practice of Harbour Engineering," by Dr. Brysson Cunningham. *Messrs. Crosby Lockwood and Son* announce a "Glossary of Aviation Terms" and "Aviation Engines," the former by Lieut. V. W. Pagé and Lieut. P. Montariol, and the latter by Lieut. Pagé. The same firm will also issue a new edition of "Refrigeration, Cold Storage, and Ice-making," incorporating the fourth edition of "Refrigerating and Ice-making Machinery," by A. J. Wallis-Tayler. "A Text-book of Naval Aeronautics," by H. Woodhouse and others, is promised by *Messrs. T. Werner Laurie, Ltd.*

OUR ASTRONOMICAL COLUMN.

NEW STARS IN SPIRAL NEBULÆ.—A full account of the discovery of a new star in the spiral nebula N.G.C. 4527 is given by Dr. H. D. Curtis in Lick Observatory Bulletin, No. 300. Photographs from various sources show that there was no trace of the star from early in 1900 until March 20, 1915, when it appeared to be of about 14th magnitude. On April 16 of the same year it had fallen to 15th magnitude, and was not certainly recognised in later photographs. Two novæ were afterwards discovered in photographs of N.G.C. 4321, and of these also the history is fairly complete. Including Ritchey's nova in N.G.C. 6946, six novæ have now been discovered in spiral nebulæ, four of them about 14th magnitude, and two brighter, one of the latter being observed in the Great Andromeda nebula in 1885. Dr Curtis considers that the appearance of these novæ strongly supports the view that the spiral nebulæ are "island universes." The average maximum brightness of novæ which have appeared in our own galaxy is about magnitude 5, and if the galactic and spiral novæ have the same absolute brightness, the difference of about 10 magnitudes indicates that the spiral nebulæ in question are of the order of 100 times as far away as the galactic novæ, which are themselves known to have been very remote. Five additional novæ in spirals are included in a list given in *Popular Astronomy*, vol. xxv., p. 632.

"COMPANION TO THE OBSERVATORY FOR 1918."—The issue of this publication for 1918 closely resembles those of previous years. In addition to a convenient series of tables relating to the sun, moon, and planets, and the satellites of Jupiter and Saturn, it includes an extensive catalogue of meteor radiants, and tables giving the times of minima or maxima of a large number of variable stars. The list of double stars has been improved by the addition of the periods of revolution, so far as they have been determined, and it now includes practically all the visual binaries of known period. There is also a useful table of astronomical constants.

HYDERABAD OBSERVATORY REPORT.—The report of the director of the Nizamiah Observatory, Hyderabad, for the year ending October 5, 1917, is chiefly noteworthy as indicating that great progress has been made with the astrographic work. The catalogue for zone $-17°$ has been finally passed for press, and the greater part of that for $-18°$ is also in the hands of the printers. For zone $-19°$ 131 plates, containing 46,186 stars, were taken, measured, and reduced during the year, and fifty-three plates for zone $-20°$ were also taken and partially measured. Mr. Pocock is to be congratulated on having so quickly brought this institution to a high state of efficiency.

PRIZE AWARDS OF THE PARIS ACADEMY OF SCIENCES, 1917.

Mathematics.—The Francœur prize to Henri Villat, for his work in hydrodynamics; the Bordin prize to Gaston Julia, for his memoir on the arithmetical theory of non-quadratic forms.

Mechanics.—The Montyon prize to René de Saussure; the Poncelet prize to Jules Andrade, for his work in applied mechanics, especially that dealing with chronometry.

Astronomy.—The Lalande prize to Robert Jonckheere, for his work on double stars; the Valz prize to Alexandre Schaumasse, for the discovery of the comet 1917*b*.

Geography.—The Gay prize to Henri Jumelle, for his books and memoirs on the geographical distribution of plants of economic value; the Tchihatchef foundation to Sir Mark Aurel Stein, for his explorations in Central Asia.

Navigation.—The prize of 6000 francs between Camille Tissot (4000 francs), for his studies of methods of protection in navigation, and G. Sugot (2000 francs), for his studies in theoretical and practical ballistics; the Plumey prize between Georges Sensener and L. Ballif (2000 francs), for their work entitled "Le Combat Aérien," and Edmé Bonneau (2000 francs), for his instrument designed to indicate at any time to aviators the position of their machine with respect to the vertical.

Physics.—The Gaston Planté prize to Henri Armagnat, for his work in the development of the French electrical industry; the Hébert prize to Hyacinthe Guilleminot, for his book entitled "Les nouveaux horizons de la Science"; the H. de Parville prize to Charles de Watteville, for his researches on flame spectra and the structure of flame; the Hughes prize to Amédée Guillet, for the whole of his researches in physics.

Chemistry.—Montyon prize (unhealthy trades) to Marius Picon and Marcel Lantenois (2500 francs), for their work on gas masks for use at the front; honourable mentions to Charles Dufraisse (1500 francs), for his chemical researches in connection with the war, and Pierre Savès (1000 francs), for his work on protection against asphyxiating gases; the Jecker prize to Emile Blaise, for the whole of his work in organic chemistry; the Cahours prize to Adolphe Lepape, for his work on radio-activity and the rare gases from mineral springs; the Berthelot prize to Gustave Vavon, for his researches on the addition of hydrogen to organic substances with platinum black as the catalyst; the Houzeau prize to (the late) André Sénéchal, for his work on chromium compounds.

Mineralogy and Geology.—The Delesse prize to Louis Gentil, for the whole of his researches in geology and physical geography in northern Africa; the Fontannes prize to Jules-Mathieu Lambert, for his palæontological work; the Victor Raulin prize to Léon de Lamothe, for the whole of his geological work; the Joseph Labbé prize to Georges Friedel, for his contributions to the geology of the Saint Etienne region; the James Hall prize to (the late) Jean Boussac, for his thesis entitled "Etudes stratigraphiques sur le Nummulitique alpin."

Botany.—The Desmazières prize to Carl Hansen Ostenfeld, for his memoir on the plankton of Danish seas; the Montagne prize to J. Pavillard, for the memoirs entitled "Recherches sur les Diatomées pélagiques du Golfe du Lion" and "Recherches sur les Péridiniens du Golfe du Lion"; the Jean Thore prize to Mme. Valentine Moreau, for her memoir on the phenomena of sexuality in the Uredineæ; the de Coincy prize to André Guillaumin, for his studies in the Burseraceæ; the de Rufz de Lavison prize to Marin Molliard, for his researches in plant physiology.

Anatomy and Zoology.—The Cuvier prize (in equal parts) between Ph. Dautzenberg and Paul Pelseneer, for their researches on molluscs; the Savigny prize to R. Jeannel, for his zoological exploration (with Ch. Allaud) in eastern Africa.

Medicine and Surgery.—Montyon prizes to Hippolyte Morestin (2500 francs), for his autoplastic work on the wounded, Ed. Delorme (2500 francs), for his researches relative to decalcification following war wounds, and Auguste Pettit (2500 francs), for his researches relating to the mode of action of various micro-organisms on the anatomical elements; three mentions (1500 francs each) to Léon Imbert and Pierre Réal, for their work on maxillo-facial surgery, to F. Rathery, L. Ambard, P. Vansteenberghe, and R. Michel, for their work entitled "Les fièvres paratyphoïdes B à l'hôpital mixte de Zuydcoote de Décembre, 1914, à Février, 1916," and to Giuseppe Favaro, for a work entitled "Richerche intorno al cuore dei vertebrati." The Barbier prize to E. Weill and Georges Mouriquand, for their researches on vitamines; from the funds of the Bréant prize 2000 francs to Jean Danysz, for his researches on the arsenobenzenes, 2000 francs to H. Gougerot, for his researches in dermatology, and 1000 francs to Maurice Courtois-Suffit and René Giroux, for their work entitled "Les formes anormales du tétanos"; the Bellion prize to Paul Fabre-Domergue, for his work on a practical method of sterilising oysters; the Baron Larrey prize to P. Chavigny, for his memoir on voluntary mutilations by firearms; honourable mentions to Léon Binet, for his work, "Le guide du médecin aux tranchées," and to André Tournade, for his work, "La pratique de l'hygiène en campagne."

Physiology.—The Montyon prize to Gabriel Foucher, for his memoir entitled "Etudes biologiques sur quelques Orthoptères"; the Lallemand prize to J. Tinel, for his work on lesions of the peripheral nerves; a very honourable mention to Stephen Chauvet, for his memoir, "Infantilisme hypophysaire"; the Pourat prize to Henri Bierry and Albert Ranc, for their work on free and combined glycose in the blood; the Philipeaux prize to Georges Stodel.

Statistics.—Montyon prizes to Henri Abraham and Paul Sacerdote (1000 francs), for the "Recueil de constantes physiques," and a mention (500 francs) to Jules Delobel, for his researches relating to the protection of infants.

History and Philosophy of the Sciences.—The Binoux prize to F. Gomes Teixeira, for his "Obras sobre mathematica," and an honourable mention to Albert Bordeaux, for his "Histoire des sciences physiques chimiques et géologiques au XIX^{e} siècle."

Medals.—The Berthelot medal to Marius Picon and Marcel Lantenois, and to Gustave Vavon.

General Prizes.—The Grand Prize of the Physical Sciences to Emile Roubaud, for his work on pathogenic trypanosomes; the Serres prize to Jean Eugène Bataillon, for his work on experimental embryogeny; the Petit d'Ormoy prize (pure or applied mathematics) to Pierre Duhem, for the whole of his work, and especially for his memoir entitled "Le Système du monde: Histoire des doctrines cosmologiques de Platon à Copernic"; the Petit d'Ormoy prize (natural sciences) to (the late) Henry Dufet, for his work in crystallography; the Saintour prize to Henri Lebesgue, for his studies on the principles of the infinitesimal calculus; the Henri de Parville prize between Charles de la Vallée Poussin (2000 francs), for his mathematical works, D. Bois (1000 francs), for his works dealing with the horticulture and popularisation of colonial plant products, and N. Lallié (500 francs), for his book, "Les moteurs agricoles"; the Henry Wilde prize between A. Claude (2000 francs), for his researches in astronomy and physics, and Georges Sagnac (2000 francs), for an apparatus useful in national defence; the Gustave Roux prize to Joseph Guyot, for his contributions to physics; the Thorlet prize to Adolph Richard, for his work in connection with catalogues of scientific periodicals in Paris libraries. The Lannelongue foundation is divided between Mmes. Cusco and Rück; the Trémont foundation (1000 francs) to Charles Frémont, for his researches on the working of metals; the Gegner foundation to Ferdinand Gonnard, for his work in crystallography and mineralogy; the Henri Becquerel foundation to (the late) Bernard Collin (1500 francs).

The Vaillant, Fourneyron, Pierson-Perrin, Damoiseau, Pierre Guzman, G. de Pontécoulant, Bréant, Godard, Mège, Argut, Fanny Emden, Alhumbert, Lonchampt, Laplace, Rivot, and Normal School prizes were not awarded this year.

COMMITTEE ON THE CHEMICAL TRADE.

THE Committee appointed by the Minister of Reconstruction to advise as to the procedure which should be adopted for dealing with the chemical trade has now concluded its deliberations and issued its report (Cd. 8882, price 1*d.* net). The Committee was appointed (1) to advise as to the procedure which should be adopted by the Minister of Reconstruction for dealing with the chemical trade; (2) to consider and report upon any matters affecting the chemical trade which could be more effectively dealt with by the formation of special organisations for the purpose, and to make suggestions in regard to the constitution and functions of any such organisation.

The members of the Committee are:—Sir Keith W. Price (chairman), Mr. John Anderson, Mr. J. F. L. Brunner, Dr. Charles Carpenter, Prof. J. G. Lawn, Sir William Pearce, Mr. K. B. Quinan, the Right Hon. J. W. Wilson, and Mr. G. C. Smallwood (secretary). The report of the Committee is here summarised.

It is evident that during the process of reconstruction numerous difficult problems and questions are likely to arise in connection with the chemical trade. The Committee is of opinion that these can be satisfactorily settled only by the closest collaboration between the Minister of Reconstruction and the representatives of the trade, and it appears to be necessary that the Minister should be in a position to obtain the views both of the trade as a whole and, in the case of particular problems, of that branch of the trade directly concerned.

This end could probably be attained in a satisfactory manner if there were in the chemical trade a representative body, which could advise the Minister and act in a consultative capacity on chemical matters. Such a body should be fully representative of the whole of the trade, and the difficulty of the Committee lies in naming an association which could be said completely to fulfil this condition.

The Committee is of opinion that, in dealing with the chemical trade, the Minister of Reconstruction could properly act in collaboration with the Association of British Chemical Manufacturers. It is further of opinion that with a view to convenience of practical working, and in order to establish the permanent link which should exist between the Ministry and the trade in all its branches, a standing committee should be established fully representative of all the interests concerned.

As to points of reference No. 2, the opinion is expressed that whatever may be the functions of the Ministry of Reconstruction, it will be necessary to establish a section of that department which will be in a position to deal with matters which may arise in connection with the chemical trade. The appointment to the Ministry of Reconstruction of a scientific man of good standing, who would command the respect and confidence of the trade, together with the necessary staff, is suggested. This section, working in conjunction with the standing committee previously mentioned, would provide the Minister with an adequate organisation for dealing with such questions connected with the chemical trade. The following would represent some of the duties of this section:—

(1) To ascertain with the assistance of the standing committee the chief problems which are likely to arise in the process of reconstruction after the war, and the best means of dealing with them. (2) To survey generally the chemical trade, both at home and abroad, and in consultation with the standing committee to afford advice for the broadening and improvement of the chemical trade of this country. (3) To collect and disseminate information on, and statistics of, the chemical trade. (4) To collect and collate as much information as is available on the work which has been done during the present war, which would, no doubt, be of great interest and assistance to the chemical trade as a whole.

The Committee states in the report that it has confined its recommendations within the narrow limits defined by the terms of reference, which speak only of "chemical trade." If, however, for that expression were substituted "the National Chemical Industry," a much broader purview would be involved, and specific reference would be necessary to existing organisations other than those specifically founded for "trade" purposes, among which may be mentioned:—The Society of Chemical Industry, the Government Laboratory, the Committee of the Privy Council for Scientific and Industrial Research, the Imperial Institute, the National Physical Laboratory, and the Chemical Society.

Summary of Recommendations.

1. That in dealing with the problems of the chemical trade action should be taken so far as possible in the closest collaboration with representatives of the trade.
2. That the Association of British Chemical Manufacturers should be considered as representative of the chemical trade as a whole with certain branches excepted.
3. That a standing committee should be appointed. This committee, which should be fully representative of all the interests concerned, would establish a permanent link between the Ministry and the trade.
4. That a departmental organisation should be set up in the Ministry of Reconstruction to deal with chemical questions.

THE PHYSIOLOGY OF LEARNING.[1]

IN the hope of throwing fresh light on the obscure problem of what goes on when animals "learn," Mr. Joseph Peterson has tested the effect of altering the length of culs-de-sac in the mazes which white rats were asked to solve on their way to the food-box. There is no doubt that the animals can learn; the question is, What precisely happens? and it is plain that the answer is not going to be easy. Organisms are very complex creatures, and animal behaviour in

[1] "The Effect of Length of Blind Alleys on Maze Learning. An Experiment on Twenty-four White Rats." By Joseph Peterson. Behaviour Monographs, vol. iii., No. 4. Pp. 53. (1917.)

many of its expressions is extremely complex. The author has no use for psychological assumptions, such as that the rat "perceives relations," or "makes practical judgments," or "has ideas." We do not know why "it is needless to say that no evidence of ideational behaviour has been found in the white rat."

When a rat emerges from a blind alley in the maze, it may run forward or it may return on its own track. But with experience the percentage of returns rapidly decreases, especially in the case of the culs-de-sac nearer the end of the journey—the food-box. There is a progressive elimination of entrances to blind alleys, but this does not come about mainly by a decrease in the *number* of entrances, but principally, especially in the case of the longer alleys, by a gradual decrease in the *degree* or distance of entrance. "Just before entrance is eliminated completely, there frequently occurs a peculiar and very rapid vibration of the rat's head between the direction of the true path and that of the tempting blind alley." Entrances to short culs-de-sac are eliminated more readily, other things being equal, than entrances to long ones.

Many facts indicate that to a large extent the maze is learned "as a whole." There must be "some sort of short-circuiting process" by which the right path is suggested for the line of action when the animal comes to the entrance of any blind alley. "It is not clear how any of the usually accepted laws of learning —frequency, recency, and intensity—can operate to bring this about. Frequency and recency fail entirely to account for the behaviour of the rat in the maze. The real process of learning, the gradual elimination of unsuccessful random acts, such as entrances to culs-de-sac and returns towards the entrance place in the maze, must be accounted for on the basis of some entirely different principle. The principles named show only how an act, directed by some other factor, becomes gradually more mechanically reflex."

What, then, is the author's theory? He calls it the "completeness of response" principle in learning. "Responses to stimuli cannot take place instantaneously, neither do stimulation effects fade away momentarily. Besides this, response tendencies and muscular strains, maintained for a shorter or longer time, constantly set up new sensory impulses (proprioceptive stimuli), which again stimulate reactions." By such means the effects of successive stimuli, such as the rat encounters in the maze, come to operate in a measure simultaneously, and the resulting response is on the whole the most consistent or complete that can be given in the whole circumstance. "The channels to this most complete response are gradually forced most open or permeable; their greater consistency of operation (facilitation) brings about an intensity of activity through them, which in repeated trials gradually short-circuits through the infinitely numerous pathways involved, and thus brings about the gradual elimination of useless random acts." This is not exactly luminous; the author's theory is only tentative.

It is suggested that learning comes about by this means, and that theories of the "stamping-in of the effects of pleasantness" or of the direction of the animal by conscious states must be laid on the shelf. It can scarcely be said, however, that Mr. Peterson's new theory has yet reached a high degree of lucidity, and there seems to us a smack of dogmatism in the brushing aside of unfashionable ideational interpretations. But the conception of the overlapping of effects of successive nerve functionings is very interesting, and we shall look forward to hearing more of it—especially as a suggested interpretation of the results of ingeniously contrived and punctiliously controlled experiments.

INTERNATIONAL FISHERY STATISTICS.[1]

THE publication of the eighth Annual Statistical Bulletin of the International Council for Fishery Investigations is of interest from the point of view of questions of post-war reconstruction. When the council began its work in 1902 it was decided that an annual summary of the commercial fishery statistics of the maritime countries of northern Europe should be compiled. Probably no one except those actually engaged in this task of compilation has ever really appreciated the difficulties of this work. There is no uniformity in the methods of collection of fishery statistics in the countries participating in the schemes of investigation; the ideals of detail and accuracy have always been very different, and official custom and tradition have made it exceedingly difficult to modify or change the methods. To all this we must add international susceptibilities; thus some of the official reports of the International Council are framed in diplomatic style and published in French, but the *Bulletin Statistique* is presented to the public in a queer mixture of English and German. Much of the matter, explanations, discussions, headings, descriptions of tables, and so on, are given in duplicate—an irritating and wasteful compromise.

There has always been (an evidently inevitable) delay in publication; thus the first bulletin, which appeared in 1906, dealt with the statistics of 1903–4, while this last one, published in 1917, summarises the data for 1911–12. The figures for the various fisheries are admittedly estimates and are rounded off, and there are, apparently, no means of arriving at any notions of the magnitudes of the errors involved. The whole treatment is very general and detail is minimal. Now, with all these defects the bulletins have achieved very much, how much anyone may attempt to estimate by trying to think of any other international industry for which we have even an approximation to the knowledge which we possess with regard to European fisheries. The defects of the bulletins are necessarily those of the national systems of fishery statistics, which are the sources of information. In May of 1914 the council began to consider changes, both with regard to arrangement and matter, and the possibilities of speedier publication. Then followed the events of the last three years, postponing indefinitely this task of reconstruction.

Apart from the improvement of the national statistical systems, any improvement of the International Bulletin would have been of little significance. Now the hiatus in fishery investigation that has existed since August of 1914 simplifies the task of reconstruction; there has been a break of continuity which really invites "scrapping" on a large scale. Nowadays there is so much uniformity in general methods of fishing and in commercial methods of distribution that there is scarcely any excuse for diversity of treatment with regard to statistics; given the will to improve and there need be no real difficulty in remodelling official methods. In almost all the national systems (the reports of the Fishery Board for Scotland are perhaps the only exception) there is an irritating and fatal absence of detail. Pedantic accuracy is unnecessary, even if it were attainable, but every local fishery should somewhere or other be recorded; as it is, generalised statements only are accessible. It is the continual experience of everyone who attempts to make use of official fishery statistics that the data are inadequate, or ambiguous, or misleading. All this imperfection must necessarily be reflected in the data of the international *Bulletin Statistique*, and rearrangement of the matter of the latter would only go a little way towards the reconstruction that is so desirable. J. J.

[1] "Bulletin Statistique des Pêches maritimes des pays du Nord de l'Europe." Vol. viii., pour les années 1911–12. Edited by Prof. D'Arcy W. Thompson. (Copenhagen, 1917.)

THE PRODUCTION OF SCIENTIFIC KNOWLEDGE.[1]

THE increase of scientific knowledge can be divided into three steps: first, the production of new knowledge by means of laboratory research; secondly, the publication of this knowledge in the form of papers and abstracts of papers; thirdly, the digestion of the new knowledge and its absorption into the general mass of information by critical comparison with other experiments on the same or similar subjects. The whole process, in fact, may be likened to the process of thought. We have first the perception by means of the senses. The percept is then stored in the memory, and in the mind is compared with other previously stored percepts, and finally forms with them a conception.

I desire in this paper to consider the methods by which these three sections of the production of knowledge may be carried on, to suggest an arrangement of laboratories to produce experimental results dealing with any branch of science, then to consider how the knowledge so obtained may best be stored and classified, and, finally, the methods to be employed to make the results of scientific research available for application.

(1) *Research Work.*

The agencies engaged in scientific research are of several kinds. The traditional home of research work is in the university, and the bulk of the scientific production of the world comes from institutions connected with teaching. The industries are more and more supporting research laboratories, a large number of which contribute to the general fund of scientific knowledge by publishing the results which they obtain, and some of which are engaged upon purely scientific work of no mean order. Consulting and technical laboratories engaged in industrial work make frequent contributions to science, and there are some very important laboratories engaged in pure research work which are supported by philanthropic foundations.

The classification of research laboratories is not altogether an easy task. They may obviously be classified according to the source of the funds which support them—that is, we may classify them as university laboratories, industrial laboratories, Government laboratories, institution laboratories, and so on—but if we look at them simply in the light of the research undertaken, this does not seem to be altogether a logical classification, since there is little distinction between the work done in some university laboratories and some industrial laboratories, and the work of the Government and institution laboratories again overlaps that of the two former classes.

The University of Pittsburg, for instance, has an industrial laboratory, where definitely technical problems are dealt with. The research work on photometry done at Nela Park and at Cornell University would seem to be similar in kind, and work on physical chemistry or on the structure of chemical compounds is of the same type, requires the same class of workers, and produces the same results, whether it be done in a university, in a laboratory of the Carnegie Institution, or in such an industrial laboratory as that of the General Electric Co. It is equally difficult to classify laboratories according to the purpose for which researches are avowedly carried on. Most university laboratories are willing to undertake work of industrial value, and, indeed, some specialise in such problems, while many industrial laboratories are quite willing to carry out a research of purely academic and theoretical interest provided the problems involved bear a relation to the general work of the laboratory.

[1] From a paper read before the Rochester Section of the Optical Society of America on October 23, by Dr. C. E. Kenneth Mees.

A useful classification of laboratories can, however, be obtained if we consider whether the problems investigated in a laboratory are all connected with one common subject or whether the problems are of many kinds, having no connecting bond of interest. I would suggest that the first type of laboratory might be called "convergent" laboratories, and the second "divergent."

In the "divergent" group of laboratories are included all those institutions where research is carried on which are interested in science in general or in science as applied to industry, and will attack any problem that may seem to promise progress in knowledge or, in the case of an industrial laboratory, financial return. Most university laboratories are of this type. When they devote themselves to special problems it is usually because of the predilection of some professor, and as a general rule a student or instructor may choose any problem in the whole field of the science in which he is working and may carry out an investigation on that problem if he be interested in it without regard to the relation of his work to the other work which is carried on in the same laboratory.

Correspondingly, in most industrial laboratories the problems investigated are those which present themselves as a result of factory experiences or of suggestions from the men working in the laboratory, and promise financial return, and the different problems carried on in the same laboratory are not necessarily related in any way whatever.

The greater number of university and industrial laboratories are necessarily of this type. It would be a disadvantage for a university laboratory, the primary business of which is training students, to be too narrowly specialised. Specialised university laboratories are desirable only in the case of post-graduate students, and it would be very inadvisable to allow the laboratories responsible for the general training of scientific men to specialise in one branch of science, since as a result the students would acquire a proper acquaintance with only a limited portion of their subject.

Industrial laboratories, on the other hand, must necessarily be prepared to deal with any problems presented by the works, and as these will be of all kinds, covering generally the whole field of physics, chemistry, and engineering, it is impossible for the usual works laboratory to specialise except in so far as it deals with the works processes themselves.

In the "convergent" laboratories, however, although the actual investigations may cover as great a range of science as those undertaken in a "divergent" laboratory, yet all those investigations are directed towards a common end—that is, towards the elucidation of associated problems related to one subject. Thus, the staff of the Geophysical Laboratory, which includes physicists, geologists, crystallographers, mineralogists, and chemists, works on the structure of the rocks, and although the field of the actual investigations ranges from high-temperature photometry to the physical chemistry of the phase rule, yet the results of all the work carried out are converged on the problem of the structure of the earth's crust.

The Nela Park Laboratory, in the same way, is studying the production, distribution, and measurement of illumination, and all its work, which may involve physiology, physics, and chemistry, is related to that one subject. Such convergent laboratories sometimes develop in universities owing to the intense interest of a professor in a single subject and to the enthusiasm which inspires students and assistants to collaborate with him and to concentrate all their energies on the same group of problems. There are many examples of such laboratories, such as the laboratories dealing with radio-activity, and those which are concerned chiefly with spectroscopy. Among others may be mentioned the Cavendish Laboratory at Cambridge and several of the larger university laboratories which deal with the physical chemistry of solutions.

But these university laboratories are rarely able to concentrate on to the group of problems which they are studying specialists from such different branches of science as are available for similar laboratories outside the universities owing to the fact that it is very difficult to obtain interdepartmental co-operation in research in a university. In a specialised laboratory, on the other hand, workers in all branches of science may well collaborate in the investigation of problems representing different points of view of one general subject.

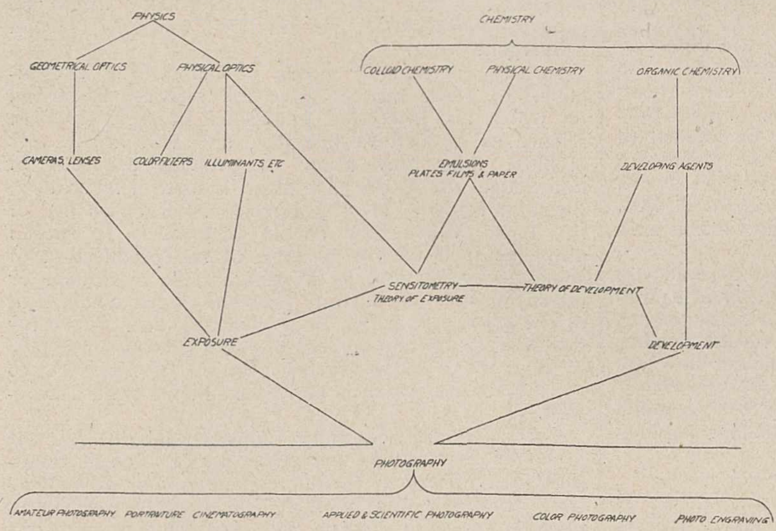

FIG. 1.

In addition to the examples of industrial and institutional laboratories mentioned above I should like to illustrate the structure of a convergent laboratory, if I may be forgiven for doing so, by referring to the organisation of the research laboratory with which I am connected—that of the Eastman Kodak Co.

The purpose of this laboratory is the investigation of the scientific foundations of photography and its applications, everything relating to photography in all its branches and applications being of interest. The branches of science which are of chief importance in photographic problems are those of optics in physics and of the colloidal, physical, and organic branches of chemistry, and the relations of these sciences to photographic problems are shown in graphic form in Fig. 1.

Optics deals on its geometrical side with the materials used in photography—cameras, lenses, shutters, etc.—and on its physical side with such materials as colour filters and illuminants, but especially with the study of the relation of the photographic image to the light by means of which it was produced—a study which is known by the name of sensitometry. The manufacture of the sensitive material itself, which on modern photographic plates, films, and paper is called the emulsion, is a province of colloid and physical chemistry, colloid chemistry dealing with the precipitation and nature of the sensitive silver salts formed in their gelatine layer, while physical chemistry informs us as to the nature of the reactions which go on, both in the formation of the sensitive substance and in its subsequent development after exposure.

The organic chemist prepares the reducing agents required for development and the dyes by which colour sensitiveness is given to the photographic materials and by which the art of colour photography can be carried on, and while the physicist therefore deals with sensitometry and the theory of exposure, the chemist must deal at the same time with the theory of development and with the conditions relating to the development of photographic images.

A laboratory, therefore, for the study of photographic problems must be arranged with a number of sections, such as are shown in Fig. 2. In physics we require departments dealing with sensitometry and with illumination, reflection and absorption, colorimetry, spectroscopy, and geometrical optics. We need a department of colloid chemistry, one of physical chemistry, one of organic chemistry, one of photo-chemistry to deal with the action of light upon the plate, and, finally, a number of photographic departments dealing with photographic chemistry, with portraiture, colour photography, photo-engraving, motion-picture work. and X-ray work, and all these departments are converged together first upon the theory, and then upon the practice, of photography.

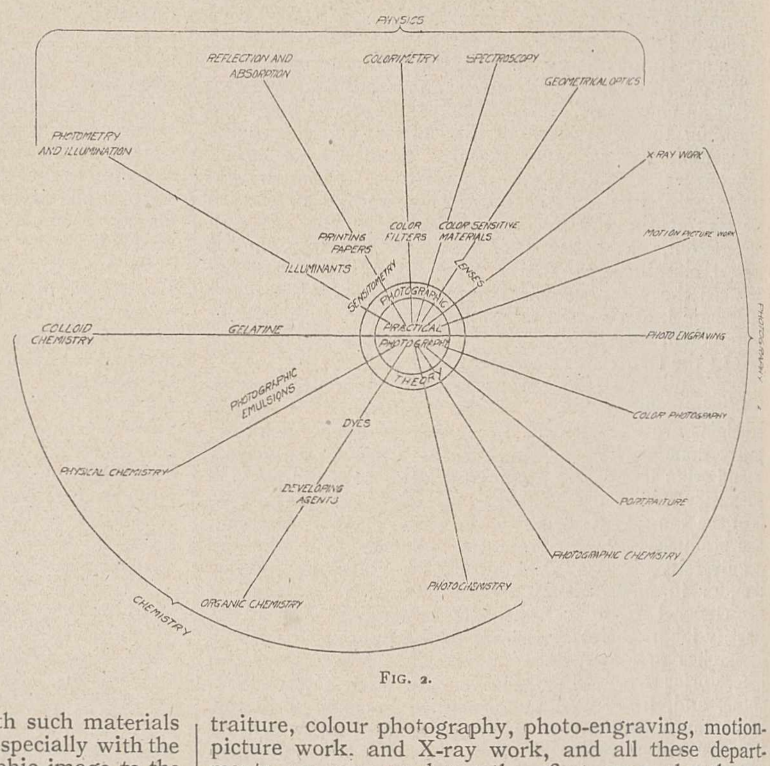

FIG. 2.

Each research specialist in the laboratory is given work corresponding with a limited field of science, so that while his special attention is devoted to that one department his field of activity just overlaps that of the departments on each side of him, while his general knowledge of the subject should, of course, cover a much wider range. It is important that each man should have his own special field of work, and that overlapping should not be complete, since such complete overlapping will inevitably produce friction destructive of co-operation and harmony. The way in which such a subdivision is arranged may perhaps be best illustrated by Fig. 3, which shows the range of the specific investigations of those who in our laboratory cover the range of research work between sensitometry and pure physical chemistry. There are five workers in this range; the first, A, being a pure physicist, B a physicist with a considerable experience of chemistry, C a physical chemist who is specialised in photography, D a physical chemist who is specialised in photographic theory, and E a pure physical chemist. The interest of each of these workers overlaps the field of the other workers, but nevertheless each of them has his own specific problem, his own equipment and apparatus. Thus, A and B use sensitometric apparatus chiefly, C both sensitometric apparatus and the thermostatic and electrical equipment of physical chemistry, D microscopic apparatus and chemical apparatus dealing with the precipitation of silver salts, and E the analytical and solubility apparatus of chemistry.

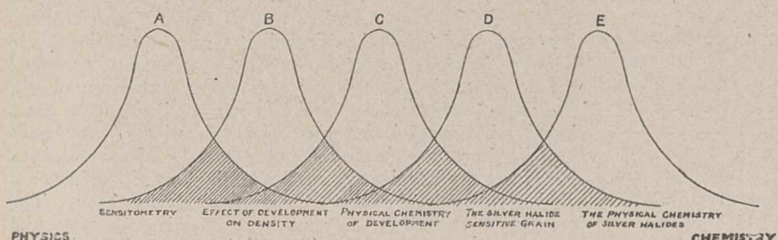

FIG. 3.

The whole of this range is also connected with colloid chemistry, and especially the overlap of the different sections involves colloid problems, so that we can consider colloid chemistry as dealing with the interrelations of the different sections of photographic chemistry, and can represent its province in the diagram by shading the overlapping areas. The colloid division of the laboratory will therefore be interested in the work of each of the specific investigators, and will be of assistance to all of them.

These charts, prepared for a photographic laboratory, are equally applicable in form for almost any other convergent laboratory, so that if we have to work out the organisation of a research laboratory which is to study any interrelated group of problems, we can do it by the construction of charts similar to these. Thus, considering Fig. 1, we place first at the bottom of the chart the general subject considered and its various branches, and then above these the scientific problems involved, separating out on opposite sides of the chart those problems which would involve different branches of pure science. Thus, we can place on one side biological problems, then physical problems, then chemical problems, and so on, so reconstructing a chart similar to Fig. 1 from the bottom up, until at the top we have the various branches of pure science involved, subdividing these branches until each subdivision represents the work capable of being handled by one man in the laboratory.

It will now be possible to draw Fig. 2, showing on the circumference the different sections of the laboratory for which accommodation, apparatus, and men must be provided, and showing the relation of these sections to the problem as a whole, and having worked this out, it is easy to find the amount of space and the number of men which will be required or which the funds available will allow for each part of the work.

Specialised laboratories may originate in various ways, but it seems clear that with an increasing total amount of research and with an increasing realisation of the importance of research more laboratories will be developed, and no doubt laboratories which originally were of the divergent type will with their growth tend to split into a linked group of convergent laboratories. Consider, for instance, a very large industrial research laboratory covering a wide field of research and dealing with many different types of problems. There are two types of organisation possible to such a laboratory. It might be divided according to the branches of science in which the workers were proficient. It might have, for instance, chemical divisions, physical divisions, and so on, but if the groups of problems dealt with were reasonably permanent in their character it would more probably develop into a group of convergent laboratories in which men from different branches of science—chemists, physicists, and so on—worked together (and probably even had their working places in proximity) because they were working on the same general problem. Any national laboratory which is developed for industrial research, for instance, should almost certainly be organised as a group of convergent laboratories rather than as a group of separate physical, chemical, engineering, etc., laboratories.

We may expect, then, that the general organisation of scientific research will tend towards the production of numbers of specialised laboratories, each of which will be working on an interrelated group of problems, and attacking it from various points of view.

Some of the questions relating to the internal organisation suitable for these convergent laboratories have already been discussed in a former paper,[2] and I need only add here that the "conference" system described there as a method of actually carrying on the scientific work of the research laboratory has continued to prove quite satisfactory.

(2) *The Classification of Scientific Knowledge.*

The work of the research laboratories is published by various methods in the form of scientific papers, and with the increasing amount of research done the number of technical journals is increasing steadily, so that the workers in most branches of science find it difficult to keep up adequately with the current literature, and especially those who become interested in the light thrown upon their own problem by other branches of science find it a task of great magnitude to acquaint themselves adequately with the literature. In order to meet this difficulty the various scientific societies publish journals giving abstracts in a conveniently indexed form of all the important papers published, and these abstract journals are of great value in searching for information on special subjects.

In spite of these abstract journals the task of obtaining all the references to the literature on a given subject is still a formidable one, and might be very much simplified by the adoption of some radical changes in the organisation of the abstraction and classification of scientific knowledge. In the first

[2] "The Organisation of Industrial Scientific Research," *Science*, 1916 p. 763 NATURE, 1916 pp. 411 and 431.

place, there seems to be no reason why abstracts of scientific papers should be prepared by the national societies. At present, for instance, there are at least four complete sets of abstracts of chemical papers prepared in different countries, together with a number of less complete sets, and this represents a great overlapping and duplication of effort. Secondly, sciences which have not so many or such wealthy workers as chemistry cannot afford to produce any complete abstract journals, so that in these sciences reference to the literature is much more difficult. There seems to be no reason why an interchange of abstracts between different countries could not be arranged, and, indeed, it might be the best method of obtaining abstracts to have the author of a paper supply an abstract suitable in form and length for the abstract journal at the same time that he sends his paper to the journal which publishes it.

(3) *The Utilisation of Scientific Knowledge.*

The actual application of science to industry is so vast a subject that it cannot be considered here, but it is not satisfactory to leave the results of research at the point where they are published in papers and filed in the abstract journals. In order to make them available as a part of scientific knowledge the new information as it is obtained must be incorporated in books.

There are three classes of books dealing with scientific work, which require separate consideration. The first class comprises the dictionaries, in which almost all the progress in some branches of science can conveniently be summarised. Beilstein's "Dictionary of Organic Chemistry" is a good example of the way in which almost all the facts of a science can be absorbed in a classified form and made available for ready reference. These dictionaries, in fact, represent the critical and discriminating summary of the scientific publications on the subjects with which they deal, and the preparation of such dictionaries should be ensured by international co-operation of the national societies.

Other sciences, however, do not by their nature lend themselves to the convenient preparation of dictionaries, and what is wanted in this case are critical and well-arranged handbooks covering the whole science, and resuming impartially, but critically, the various additions which are made from time to time in the different branches of the subject. These handbooks, as well as the dictionaries, would, of course, require the addition of supplementary volumes from time to time, and occasional complete revision.

The preparation of both dictionaries and handbooks would, of course, be greatly facilitated by the existence of a numerically classified card index to the literature concerned, and the preparation and revision of such books might well be undertaken in connection with the large libraries having in their possession the complete classified card indexes.

On the other hand, for the assistance of advanced students of science, what is required is a steady supply of monographs correlating critically and comprehensively all the literature in a special field, and these must be brought up to date from time to time. Such monographs are especially required in connection with rapidly developing new branches of science; it is difficult to over-estimate the importance and value for progress in research of such a book as Bragg's "X-rays and Crystal Structure," for instance, and while nothing should be done to hinder individual initiative in publishing such books, it would seem that when it was apparent that some branch of science required such a monograph a national society might very well approach well-known workers in the field and request them to write such a book, offering its assistance in the matter of bibliography, and also offering to arrange for the publication of the manuscript.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Science Museum, South Kensington, was reopened to the public on Tuesday, January 1. The museum has been closed to the public for nearly two years; it has, however, been open without interruption for students. As compared with 1914 conditions, the extent and the hours of opening for 1918 are somewhat reduced, but the greater part of the museum will be open free on every weekday from 10 a.m. to 5 p.m., and on Sundays from 2.30 p.m. to 5 p.m. The collections contain many unique objects of great interest as representing discoveries, inventions, and appliances that have been of first-rate importance in the advancement of science and of industry. Such objects as Watt's engines, early locomotives, steamships, flying machines, reaping machines, and textile machinery are records of British contributions to the progress of the world; and it is gratifying that these can again be made available for inspection by visitors to London from all parts of the United Kingdom and from distant parts of the Empire.

A COPY of the calendar for the session 1917–18 of the University of Sheffield has been received. In addition to the courses of study arranged for students preparing for graduation in the ordinary university faculties, many other departments, designed to meet the more special needs of the area served by the University, have been inaugurated. Among these may be mentioned the two years' course of work in the University and the Sheffield Training College of Domestic Science; lectures on welfare work for men and women; and an extensive system of University extension work. The departments of applied science are intimately associated with local industries. The faculty of engineering, for instance, includes departments of mechanical, electrical, civil, mining, and chemical engineering, applied chemistry, building, and glass technology. The faculty of metallurgy is concerned with ferrous and non-ferrous metallurgy. The diplomas and certificates of the University are recognised as exempting from examinations for admission to many professional institutions; and the University has, also, been recognised by the Home Office as an approved institution for the examination of mine surveyors. A research delegacy in glass technology, consisting partly of members of the University and partly of representatives of the glass industry, has been instituted. The aims of the delegacy are to promote research in glass technology and to provide for the teaching and training of students in this subject.

AN interesting account was published in the *Times* of December 29 of "Khaki College," a school of civil learning which has been inaugurated in a division of the Canadian Army stationed at Witley Camp in Surrey. Khaki College is the expression of the spirit and ideal of a young and vigorous Oversea nation; and its most important aim is to help young soldiers, whose studies may have been interrupted by the war, still to equip themselves for the return to civil life. At a camp there is little for the men to do in the evenings, and those responsible for providing healthy recreation for the Canadian soldiers organised regular meetings of men under a tree in the "Pine Grove" to discuss questions of academic interest, and to listen to lectures by officers in command. Soon a demand arose for regular classes, and the would-be students were so many that the authorities of the Canadian Army decided to organise Khaki College. The teaching staffs are recruited from within the Canadian Army, and consist of university professors and others. The courses of lectures cover classics, history, modern languages and literatures, mathematics and engineering, business and agriculture; and the Senate is prepared to establish classes, in any subject whatever, for which there is sufficient demand. Students from the Canadian universities serving in the Army will have their Khaki College work "credited" on the return. When demobilisation sets in, some time must elapse before the Canadian soldiers then in England can be repatriated; Khaki College, while equipping men for their return to civil life, will prevent them from degenerating into vicious habits of idleness apt to ensue from a prolonged life in the base camps. It is this aspect of the movement which first appealed to the High Canadian Command, and it is to anticipate the problems of the period of demobilisation that the High Command has encouraged the establishment at the front of the University of Vimy Ridge. That institution is, indeed, established on a basis quite as elaborate as the institution at Witley. Some idea of the scope of its work is afforded by the long list of lectures on history and economics, applied science, languages and literature, agriculture, and business. At Witley there are 200 studying scientific agriculture, and 200 taking the business course. There are 150 students of history, 125 of English, 75 of the classics, 100 of French, 50 of mathematics, and smaller numbers in other courses.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Microscopical Society, December 12, 1917.—Mr. E. Heron-Allen, president, in the chair.—W. **Bateson**: Cytology and genetics. Attempts to find regularity in the distribution of chromosome numbers had generally been unsuccessful, but attention was directed to the recent work of Winge, who, by preparing a graph of these numbers in plants, had shown that simple multiples of 2 and 3 occur with special frequency, while prime numbers are rare and exceptional. A survey was given of the phenomena of linkage between genetic factors as demonstrated in breeding experiments, with a discussion of Morgan's suggestion that this linkage is due to a linear arrangement of the linked factors in the same chromosome. Whether the proposition in its entirety was established or not might be doubtful, but the factors certainly behaved as if arranged in lines, and, as represented by the theory, a great diversity of genetic and cytological observations relating to the heredity of sex and other characters assumed an orderly form.—G. S. **West**: A new species of Gongrosira. A lime-encrusted alga, forming somewhat nodular masses 4–9 mm. thick, of a vivid green colour, was found at Westen Mouth, Devon, growing in such a position that it received the full force of a stream of water falling about 2 ft. It proved to be new, and is described as *G. scourfieldii*.

Aristotelian Society, December 17, 1917.—Dr. H. Wildon Carr, president, in the chair.—Dr. G. E. **Moore**: The conception of reality. Bradley asserts both (i) "Time is not real," and (ii) "Time exists, is a fact, and is"; and he evidently thinks that these two assertions are compatible. In truth, however, (i) ought to include, as part of its meaning, "There are no temporal facts," while (ii) ought to include, as part of its meaning, "There are some temporal facts"; so that the two assertions are not compatible. It is suggested that the reason why Bradley supposes them to be compatible is because he sees (*a*), what is true, that "Temporal facts are unreal" is compatible with "We think of temporal facts," and supposes also (*b*), what is false, that "There are no temporal facts" is compatible with "We think of temporal facts." If (*a*) and (*b*) are both true, it would follow that "Temporal facts are unreal" could not include as part of its meaning "There are no temporal facts"; and that hence (i) must be compatible with "There are some temporal facts." In truth, however, there is no difficulty in supposing that (*b*) is false.

EDINBURGH.

Royal Society, December 3, 1917.—Dr. Horne, president, in the chair.—Principal A. P. **Laurie** and A. **King**: Note on the hydrolysis of acid sodium sulphate. These experiments were carried out with the view of throwing light on a practical problem arising in the manufacture of explosives, and are an investigation of the effects of cooling solutions of acid sodium sulphate of various strengths, showing the laws governing the separation of the normal salt.—Dr. W. Wright **Wilson**: The absence of a nucleus in crystals of uric acid. It was suggested that the lack of a nucleus might be hereditarily connected with abnormal conditions.—A. M. **Williams**: The thermodynamics of adsorption. This thermodynamic investigation into heat effects accompanying adsorption led to expressions for three isothermal heats of adsorption of a gas and for the heat of immersion of a powder in a liquid. The effect of the variation of the surface of an adsorbent when adsorbing was examined, and it was shown from Titoff's observations that the divergence between calculated and observed values of the heat of adsorption could be explained on the assumption of a change of surface area. The fractional change of surface per c.c. adsorbed could be calculated, and also the surface energy per gram adsorbent *in vacuo*.—R. K. S. **Lim**: Experiments on the respiratory organs of the shore-crab (*Carcinus maenas*). The following facts were established. The direction of the respiratory current in the shore-crab is from behind forwards, whether the animal is lying above sand or buried in it. Occasionally this direction is reversed. Sea-water is sucked in beneath the carapace through four separate spaces which communicate with corresponding spaces between the gill origins. The direction of these inlets is such that the current in the gill chambers tends to travel forwards and inwards. The gills being radially arranged, and being placed across the path of the current, forces it to pass through the individual gill lamellæ, thus thoroughly bathing their surfaces.

PARIS.

Academy of Sciences, December 3, 1917.—M. Paul Painlevé in the chair.—E. **Picard**: A functional equation occurring in the theory of the distribution of electricity according to Neumann's law.—M. Vito Volterra was elected foreign associate in the place of the late M. Hittorf.—W. **de Tannenberg**: A question of indeterminate analysis.—J. **Bosler**: Meteorites and terrestrial eccentricity.—C. **Matignon** and F. **Meyer**: Monovariant equilibria in the ternary system, water, sodium sulphate, ammonium sulphate. An account of experiments undertaken to supply a rational solution of the problem of the preparation of ammonium sulphate from sodium bisulphate.—E. **Hildt**: New fractionating apparatus for petrol and other volatile products. The vapours are passed through a series of six Vigreux columns heated externally by the vapour of a petrol boiling between two well-defined temperatures. The vapour uncondensed by the first column passes on to a second column similarly vapour-jacketed with a lower boiling liquid. The apparatus figured shows six such columns in use, giving fractions $>150°$, $130°–150°$, $110°–130°$, $90°–110°$, $70°–90°$, $50°–70°$, $<50°$ C. Among the advantages claimed is the elimination of errors due to currents of air and to changes in the barometric pressure.—J. **Laborde**: A new method for the separation and estimation of lactic, succinic, and malic acids in wine. The method is based on the differences in solubility of the calcium salts of the three acids in alcohol of varying concentration.—F. L. **Navarro**: The non-existence of the Cretacean in the island of Hierro (Canaries). The author, after visits to the island of Hierro in 1911 and 1917, has definitely proved the absence of Cretaceous deposits. The fossil, *Discoidea pulvinata*, described by J. Cottreau and P. Lemoine in 1910, was probably brought to the island by a ship as ballast.—F. **Georgévitch**: The evolutive cycle of *Myxidium gadii*.—A. **Lécaillon**: Aptitude for natural parthenogenesis considered in various races or varieties of the silkworm.—L. **Boutan**: The *rôle* of the fins in teleostean fishes with swimming bladder.—W. **Kopaczewski**: The mechanism of the toxic action of the serum of the muræna.

CAPE TOWN.

Royal Society of South Africa, October 17, 1917.—Dr. A. Jasper Anderson, vice-president, in the chair.—J. **Moir**: Spectrum phenomena in the chromium compounds, being part iv. of the spectrum of the ruby and emerald. It has been found that although aqueous solutions of the chromium salts do not show any narrow characteristic bands in the spectrum, yet when anhydrous (or nearly anhydrous) solutions are used the spectrum is crossed by narrow bands in the red similar to what are seen in the ruby or emerald spectrum. The solutions of chromium oxide in concentrated sulphuric and in fused metaphosphoric acid have been investigated, and the bands measured; they are very similar to those seen in the emerald, but not absolutely identical; while the bands of the ruby, although similar in arrangement, are displaced into a region of lower frequency. Both gem colours are due to chromium, but the vibrations are differently loaded (silica and beryllia against alumina).—J. **Moir**: Colour and chemical constitution. Part iii.: Derivatives of the unknown ortho-para-phenolphthalein. Phthaleins in which one of the hydroxyl groups is ortho- and the other para- to the central carbon have been prepared from para-substituted phenols with oxybenzoylbenzoic acid. They are like the common phthaleins, but their absorption bands are broad, although in much the same position.

BOOKS RECEIVED.

The University of Sheffield. Calendar for the Session 1917–18. Pp. 767. (Sheffield: The University.)

Medicinsk—Historiske Smaaskrifter. 18. Om Lægekunst Hos Perserne. By A. Christensen. (København: Vilhelm Trydes Forlag.)

The Education of Engineers. By H. G. Taylor. Pp. vii+64. (London: G. Bell and Sons, Ltd.) 2*s*. net.

Chemistry for Beginners. By C. T. Kingzett. Second edition. Pp. viii+150. (London: Baillière, Tindall, and Cox.) 2*s*. 6*d*. net.

Les Universités et la Vie Scientifique aux Etats-Unis. By Prof. M. Caullery. (Paris: A. Colin.) 3.50 francs.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 3.

ROYAL INSTITUTION, at 3.—Electricity as an Illuminator and Doctor: Prof. J. A. Fleming.

CHILD STUDY ASSOCIATION, at 5.30.—*Discussion*: The Education of the Clever Child: Openers: G. F. Daniell and Miss M. Berryman.

ASSOCIATION OF SCIENCE TEACHERS (University College, Gower Street), at 11.30.—Some Applications of Physics: Prof. Dovidge.—At 2.30.—*Discussion*: The Teaching of Physics in Girls' Schools: Opener: Prof. F. Womack.

SATURDAY, JANUARY 5.

ROYAL INSTITUTION, at 3.—Electric Dynamos, Motors, Transformers, and Railways: Prof. J. A. Fleming.

GEOGRAPHICAL ASSOCIATION, at 11.30.—The Crafts of Britain, Past and Future: H. Wilson.—At 3.—Map Study in Geography and Military Education: W. E. Whitehouse.

MONDAY, JANUARY 7.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Toxicity of Methyl Alcohol in Relation to its Industrial Uses. A Review of the Published Data: T. D. Morson.—The Rapid Estimation of Pyridine in Ammonia: T. F. Harvey and C. F. Sparks.—(1) Corrosion of Lead Roofing; (2) The Action of Rainwater on a Portland Stone: Prof. J. S. S. Brame.

GEOGRAPHICAL ASSOCIATION (London Day Training College), at 10.30.—*Discussion*: Geography in Advanced Courses: Openers: Miss Odell, L. Brooks, and W. H. Barker.—At 5 (King's College).—Presidential address: The Great Goddess Mother Earth: Sir W. M. Ramsay.

ARISTOTELIAN SOCIETY, at 8.—Is there a Mathematics of Intensity?: Prof. J. A. Smith.

ROYAL GEOGRAPHICAL SOCIETY (Kensington Town Hall), at 3.30.—The Yukon since the Trail of '98: Mrs. George Black.

TUESDAY, JANUARY 8.

ASSOCIATION OF PUBLIC SCHOOL SCIENCE MASTERS (City of London School), at 12.15.—President's address: The Needs of our Education at the Present Day, with Special Reference to Science Teaching.—At 3.—*Discussion*: Compulsory Science in University Entrance Examinations: Opener: O. H. Latter.—At 3.45.—*Discussion*: Examination or Inspection as a Test of Science Teaching: Opener: G. F. Daniell.—At 5.15.—*Discussion*: Subsidiary Subjects in University Scholarship Examinations: Opener: H. de Havilland.

ROYAL INSTITUTION, at 3.—Electric Telegraphs and Telephones: Prof. J. A. Fleming.

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—A Statement in Commemoration of the Founding of the Institution on January 2, 1818.—Rail-Creep: F. Reeves.—Creep of Rails: H. P. Miles.

WEDNESDAY, JANUARY 9.

ASSOCIATION OF PUBLIC SCHOOL SCIENCE MASTERS (City of London School), at 11.—*Discussion*: "Descriptive Astronomy" in the "Science for All" Course: Openers: Rev. A. L. Cortie, S.J., E. O. Tancock.—At 12.—*Discussion*: "Map Work" in Schools.

MATHEMATICAL ASSOCIATION (London Day Training College), at 5.30.—The Graphical Treatment of Power Series: Dr. W. P. Milne.

GEOLOGICAL SOCIETY, at 5.30.—The Highest Silurian Rocks of the Clun Forest District (Shropshire): L. D. Stamp.

THURSDAY, JANUARY 10.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Electrical Signalling and Control on Railways: C. M. Jacobs.

MATHEMATICAL ASSOCIATION (London Day Training College), at 11.—The Uses and Functions of a School Mathematical Library: Dr. W. P. Milne.—Nomography: Dr. S. Brodetsky.—Some Suggestions for a Presentment of Mathematics in Closer Touch with Reality: G. Goodwill.—At 2.30.—President's address: Mathematics and Individuality: Prof. T. P. Nunn.—*Discussion*: The Position of Mathematics in the New Scheme of the Board of Education for Secondary Schools: Openers: W. D. Eggar, P. Abbott, Miss J. Dow.

FRIDAY, JANUARY 11.

ROYAL GEOGRAPHICAL SOCIETY (Kensington Town Hall), at 3.30.—The Old Life in Egypt: Miss Mary Brodrick.

ROYAL ASTRONOMICAL SOCIETY, at 5.

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