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Economics of Standardisation.

At the recent meeting of the British Association in Glasgow, Mr. C. Le Maistre read a paper to Section F (Economic Science and Statistics) on "Standardisation and its Economic Basis." He stated that engineers and many progressive business men are, generally speaking, converted to the benefits of standardisation, carried out nationally with the strictest precautions to prevent interference with invention and design and with proper arrangements for review and revision when practical experience and progress dictate.

Since the War, the producing countries have been forced by economic pressure, and the hope of increasing their export trade, to give far greater attention to this subject than hitherto, though no country has given it greater attention or more publicity than the United States of America. This will be appreciated when it is stated that in 1926 it was estimated that more than one and a half million pounds were expended in that country on standardisation. It was stated then that there were five national standardising bodies, more than 190 trade organisations, and more than 50 government bureaux doing standardisation work of one sort or another. No doubt there has been considerable overlapping of effort, but large economies must have resulted or the work would not have been undertaken.

In Europe, while we in Great Britain have the oldest national organisation, Germany has probably the largest scheme of standardisation, and is influencing the whole of the Continent in that direction. It has often been stated that the Germans thereby hope to capture the export trade, especially of the engineering and allied industries. In any general discussion on such a subject, Mr. Le Maistre pointed out, it is of the utmost importance that the terms used by the various speakers should, if possible, be identical, or at any rate should approximate to such a degree as to avoid misunderstanding.

Most people will agree that no movement has ever been so hampered by its title as standardisation, for the term lends itself to many interpretations. It is often thought to imply crystallisation, whereas the movement, at any rate in Great Britain, stands for an entirely progressive and co-operative effort. Mr. Le Maistre distinguished between dimensional standards and those of quality, rating, performance, and tests, the latter of which enable comparisons of tenders to be made. A further division—a somewhat arbitrary one—of simplification has also to be considered.

The United States Government, up to the present, appears to have regarded simplification as the more commercial part of the process, dealing solely with the reduction of the variety of types to the least possible number. Industrial standardisation, according to the experience of the British Engineering Standards Association, provides an equitable basis for the comparison of tenders by simplifying and standardising both on the production side as well as on the commercial side, thus benefiting both the producer and the consumer. The first piece of work of the Association, more than a quarter of a century ago, was that of simplifying the large variety of steel sections then being made. These were finally reduced to 113, thereby saving at that time 5*s*. per ton, or a million a year.

It is quite possible that in America it may be found expedient to make less and less distinction between the two processes. In Great Britain experience has shown repeatedly that with the community of interest of purchaser and producer recognised in the work, simplifying practically always leads to agreement on industrial standards.

It would seem that the greatest benefits are likely to accrue in those industries which are well organised and therefore able to arrive at a consensus of opinion of their industry on the various problems involved. The success of the B.E.S.A., which is not a profit-making concern, is in large measure due to its recognition from the outset of the community of interest between producer and user. Its committees are representative of all interests concerned.

In Great Britain dimensional standardisation has not been carried so far as on the Continent, where apparently only of recent years have the economic benefits of establishing standards of comparison for tenders been appreciated. On the other hand, one must not forget that interchangeability coupled with drastic simplification has contributed very largely to the success of the American motor-car industry. According to that vast organisation known as "General Motors," a motor car consists to the extent of nearly 70 per cent of minor parts. In their works these minor parts have been reduced from 13,000 to just above 2000.

What is true of the motor industry must be true of other industries, at any rate to a considerable extent. In Great Britain, because of our geographical position, our manufacturers are very diversified and we are probably unable to undertake an extensive scheme of simplification with any possibility of economic success. On the other hand, a great deal could be done through closer contact between the technical and commercial departments of various firms. It would not do, however, to merge individuality in too much standardisation. In fact, while experience shows that industrial standards arrived at nationally, which provide an equitable basis of comparison, be it for quality, performance, or tests, are invaluable aids to economic production and tend to simplify commercial transactions, there is no doubt that too much simplification and standardisation of particular articles has the danger of leading to sterilisation.

Medieval Indian Mathematics.

Archæological Survey of India. New Imperial Series. Vol. 43, Parts 1 and 2: *The Bakhshāli Manuscript; a Study in Mediæval Mathematics.* By G. R. Kaye. Pp. iv + 156 + 48 plates. (Calcutta: Government of India Central Publication Branch, 1927.) 28 rupees; 43*s*. 6*d*.

THE Bakhshālī MS. is a valuable and interesting document in the history of mathematics. The work of editing it must have been extremely difficult and laborious, and the editor is to be heartily congratulated on the result, which really leaves nothing to be desired in the shape of aids to the study and appreciation of the contents of the MS.

Mr. Kaye is a recognised authority on the history of Indian mathematics, and the work could not have been in better hands. Part 3 still remains to be published, but Parts 1 and 2 now before us make a handsome volume of large quarto size containing, besides five plates reproducing the original text in facsimile, a transliteration of the whole covering 52 pages, illustrations of the script of this and other MSS. for the purpose of comparison, and a very comprehensive introduction of 99 pages, giving a conspectus of the work with all necessary elucidations, historical and otherwise, save for a more detailed discussion of the language and script which is reserved for Part 3. Chapter i. gives the story of the finding of the MS., Chapter ii. a description of the material used (birch-bark) and of the present condition of the MS., Chapter iii. the order of the leaves; Chapter iv. describes the contents generally and classifies the problems in groups, Chapter v. is on the exposition and method, and Chapter vi. contains a complete and detailed analysis of the contents of each group of problems. Chapter vii. deals with the measures used in the MS., Chapter viii. with the sources, and Chapter ix. with the age of the MS. and the date of the work. For the historian of mathematics unacquainted with Sanskrit

and its dialects the essential chapters are iv., v., vi., viii., ix.

The MS. was found in a field at Bakhshālī, near Mardan, on the north-west frontier of India. The place was near a well, with no trace of any building near it. So fragile was the MS. that the finder destroyed part of it in taking it up. The material is birch-bark; about seventy leaves are left, though some of them are mere scraps. A few are stuck together, though it might be possible to separate them. The MS. was first given to the late Dr. E. S. Hoernle, then head of the Calcutta Madrasa, to be deciphered and published. Dr. Hoernle wrote a description of it, which was published in the *Indian Antiquary* in 1883; this he followed up by a fuller account, including a translation of a few leaves, which appeared in the same journal in 1888. Dr. Hoernle also analysed a considerable part of the text, but, being prevented from carrying out his intention of publishing a complete edition, he handed over most of the material to the present editor, who at his request undertook to carry on the work. The MS. was presented by Dr. Hoernle to the Bodleian Library in 1902.

Dr. Hoernle thought that the MS. could not be later than the tenth century, but that it was a copy of an original treatise which might go back so far as the third or fourth century. Mr. Kaye has given good reasons for questioning the latter view and for believing that the date of the MS. is probably about the twelfth century (the century of Bhāskara, born 1114, and Omar Khayyám). The treatise is unquestionably Indian, but shows traces of western influence. Among the important things for the historian of mathematics are the following:

1. The arithmetical notation is on the place-value system, and there is no sound evidence of the employment of such a system earlier than the tenth century in the case of inscriptions, the eleventh in the case of coins, and the twelfth in MSS.

2. The early Indians (after Āryabhaṭa and Varāhamihira, fifth and sixth centuries) used the western sexagesimal notation for astronomical purposes, but not in purely arithmetical calculations. The Muslim mathematicians, on the other hand, did employ this notation to express ordinary fractional quantities. Now in the Bakhshālī MS. there is an example of the transformation of an ordinary fraction into its equivalent in sexagesimal fractions, namely, $\frac{178}{29} = 6 + 8^{\mathrm{i}} + 16^{\mathrm{ii}} + 33^{\mathrm{iii}} + 6^{\mathrm{iv}}\frac{6}{29}$.

3. Our MS. commonly employs a method for obtaining approximations to square roots which is not Indian. This method gives for a_1, the first approximation to the surd $\sqrt{(A^2+b)}$, the expression $A+(b/2A)$, and our treatise regularly uses this rule (a) for finding a_1, and (b) for deducing from a_1 a second approximation, a_2. The rule is Greek, for Heron gives its equivalent, and there is no doubt that it was used by Archimedes and others much earlier. On the other hand, the rule does not appear in any Indian work before the sixteenth century. The appearance, therefore, of the method in our MS. is probably due to direct western, and possibly Muslim, influence.

4. Two mathematical symbols are employed. One is a sign for the unknown quantity which is •, the same symbol as is used for zero. The other is a sign for 'minus,' which is, strangely enough, like our sign for +, but is placed after the number affected instead of before it. The origin of the latter sign has not been explained; it would be rash to identify it with Λ, Diophantus' sign for 'minus.'

The types of problem solved in the MS. may be classified thus:

1. Systems of linear equations of the type $x_1+x_2=a_1$, $x_2+x_3=a_2$, . . . $x_n+x_1=a_n$ (n odd), and other systems of the same type as those of the famous "Epanthem" of Thymaridas the Pythagorean. The *regula falsi* is one of the methods of solution.

2. Two linear equations between three unknowns are solved in positive integers. This problem, which appears to have originated in China so early as the sixth century, is not elsewhere on record in India before Mahāvīra (ninth century). It was popular in Europe in early medieval times, and later became known as the *regula virginum* or *regula potatorum*.

3. There are cases of indeterminate equations of the second degree, one being of Diophantine type, solved ἁs in Diophantus, and another being $xy-ax-by-c=0$.

4. Motion-problems about persons moving at different speeds and meeting or passing one another.

5. Quadratic equations and approximations to square roots.

6. Series, especially arithmetical progressions, including the determination of the number of terms when the first term, the common difference, and the sum of the terms are given.

7. Problems of earning and spending, profit and loss.

8. Miscellaneous problems, generally solved by the rule of three. T. L. H.

Preston's 'Light.'

The Theory of Light. By the late Dr. Thomas Preston. Fifth edition, edited by Prof. Alfred W. Porter. Pp. xxiv + 643. (London: Macmillan and Co., Ltd., 1928.) 25*s.* net.

IN the course of time every scientific book is overtaken by one of two fates; it lapses into oblivion or it is canonised as a classic. In the latter case there is always a temptation to extend its working life by the issue of revised and modernised editions. There is, of course, no objection to this so long as the author himself is able to undertake it, but after his death it becomes increasingly difficult to fuse the additions with the original into a homogeneous whole. The new 'Preston' is the fifth edition and Prof. Porter the third editor, so that it would not have been surprising, in view of the development of the subject since 1890, if the 'joins' had shown here and there. As a matter of fact they are less evident than in the previous edition, in spite of the extensive modifications for which the present editor is responsible. He has wisely removed, for example, all direct indications of interpolated matter such as were rather unnecessarily given by his predecessors. The new diagrams are more easily recognisable, since they are all black on white ground, whilst Preston's are nearly all white on black ground. In order partly to compensate for the considerable additions he has made, Prof. Porter has removed some matter, mainly mathematical, which will certainly never be missed by the majority of readers.

The new matter falls mainly under the head of physical optics, but some additions are made in geometrical optics also, notably in connexion with thick lenses and the theory of aberrations. This is all to the good, since the original version was decidedly weak in these directions, but the treatment is still rather brief in comparison with that accorded to other sections of the subject. Another topic which quite justifiably claims more space than formerly, is that of resolving power of optical instruments. In order to avoid the common confusion between this quantity and a totally different one, the so-called 'resolving power' of spectroscopes and interferometers, the term 'chromatic resolving power' is introduced to designate the latter. This is an innovation which should be welcomed and adopted by all teachers and students of the subject, particularly as Prof. Porter handles these matters in lucid and masterly fashion.

The section on diffraction has been largely recast with the view of distinguishing more definitely than is usual between the Fresnel and Fraunhofer types of fringes. Some important additions have been made to the theory of the diffraction grating, the discussion of the intensity distribution being especially valuable in view of the misconceptions which are prevalent amongst students—and some others. The newer interferometers (Fabry-Perot, Lummer-Gehrcke and echelon) are adequately treated from the purely theoretical point of view, but it would have been very instructive to bring out more clearly the relationships between them and to contrast their properties in some detail. The determination of stellar diameters by Michelson's interferometer method is naturally the subject of an additional section, and the theory is presented in a very neat and concise form. An account is also given of Michelson's very recent measurements of the velocity of light.

Of the remaining changes, the most important is an expansion of the treatment, previously very brief, of the electromagnetic theory, so as to include the phenomena of reflection, refraction, dispersion, and propagation in crystalline media. The necessary space for this is appropriately secured by judicious abbreviation of the elastic solid theory. A minor reform, but one which will be a great boon to the assiduous reader, is that index references are now to pages instead of to sections as formerly, but the latter system is still retained in the text.

There are a few trivial misprints, and in several cases references to other sections are erroneous on account of their having been renumbered. The production is entirely admirable, and it is beyond question that the value of the book has been very considerably increased. So has the price, but by present standards it is by no means excessive.

Experimental Zoology.

Experimental Embryology. By Prof. T. H. Morgan. Pp. xi + 766. (New York: Columbia University Press; London: Oxford University Press, 1927.) 37*s.* 6*d.* net.

UNTIL quite recently, experimental methods in zoology were restricted to comparatively isolated fields of research and there seemed little prospect of their application to problems of general interest. For half a century the concepts of phylogenetic morphology not only maintained their own intrinsic interest but also were the source of peculiarly sound and fruitful work. To-day, how-

ever, the situation is more uncertain. There seems to be a tendency to regard morphology as a science the days of which are over, and to regard experiment as a more vigorous and hopeful source of zoological discovery. Almost at the opening of his career, a zoologist is faced with alternative points of view: Is it more fruitful to look upon organisms as a series of evolutionary and morphological units, or as dynamic systems the changes of which are themselves clues to their origin and behaviour?

Those who have felt the inspiration of the older methods may, perhaps, rightly discount the enthusiasm of recent years for new conceptions and for new technique. The phylogenetic point of view has, in the past, established a series of facts unparalleled in the history of science, and these facts must inevitably lie at the foundation of all our knowledge. That morphology should cease to demand exclusive attention is, nevertheless, a natural stage in the evolution of knowledge, and the claims of experimental zoology to-day are neither more nor less than those which have arisen in the history of all exact sciences. We cannot go on building foundations for ever; sooner or later it is profitable to erect more ambitious structures. Basing a study of function upon a knowledge of its form, experimental zoology claims to give a deeper insight into the structure and behaviour of a living organism.

It is a striking tribute to the success of its early labours that the new point of view should stand its trial so soon before the established advocates of morphology, who rightly will not temper justice with mistaken sentiment. There can be little doubt that in the not far distant future, both morphology and experimental zoology will find their common level wherever zoology is being taught. The day will come when morphologist and experimenter will realise that their goal is the same although their lines of approach appear, at first, to diverge. For the moment, it is more profitable to seek for common ground of understanding than to provoke unreal, if not unfriendly, criticism.

To those who love experiment, and to those who seek to help by understanding a novel point of view, Prof. Morgan's book is of more than usual value. For the first time, an analysis of the living embryo has been made by one who is not only perhaps the greatest of living geneticists but is also a pioneer of experimental zoology. The value of the book not only lies in a rich accumulation of facts but also in the point from which these facts are viewed. The living embryo is neither a series of microscopic sections nor is it an amorphous mass inside a test-tube. Throughout the pages of this book there is a delightful absence of technical conceit, and a commendable lack of wearisome morphology. For this reason the book will be read with pleasure and delight by those whose views are widely different. Relevant facts are not excluded because they are old, but with critical ability of a high order the author welds together data from ever-widening fields of research.

Few specialists will read Prof. Morgan's work without finding points for criticism. Some will read with surprise the chapter devoted to the mechanism of organ formation. Others will find it difficult to afford support to the view that "there is nothing in the changes in shape of the different parts of the embryo that is beyond the range of explanation of ordinary physical and chemical processes. If by means of surface tension and of swelling we can account for so many of the initial steps in organ formation, it seems not unreasonable to expect that a fuller knowledge of other changes may furnish equally simple solutions."

These remarkable statements seem to be based on a very doubtful analogy between a living gastrula and certain very simple colloidal systems. Analogies of this type, though interesting in themselves, are liable to be dangerous and deceptive guides. No simple explanation of biological phenomena is likely to be true, nor should it be entertained unless capable of experimental proof. One feels that, at times, Prof. Morgan's enthusiasm for new methods leads him further than is generally regarded as safe. To labour such criticisms would be unfortunate. To run too fast is better than not to run at all, and when the pace is set by a man of outstanding ability, it is for us to follow if we can.

To Prof. Morgan the value and significance of experiment has long been obvious, and his book will do much to establish and consolidate a growing science. It is the first attempt to raise, on the foundations of morphology, an edifice not unworthy of the past. J. G.

Cotton and Spinning.

Studies of Quality in Cotton. By Dr. W. Lawrence Balls. Pp. xxvii + 376 + 18 plates. (London: Macmillan and Co., Ltd., 1928.) 20*s.* net.

IT would not be correct to describe this book either as a text-book or a research report; nor yet even a philosophical discourse: for it is something of all three, and, withal, undoubtedly the most interesting and stimulating that has been written round the subject of cotton. As the author

puts it in the introduction, the object of the work described herein is to bring the "Spindle to the Hoe"; by which is meant the reconciliation, by scientific treatment, of the aims of the grower with the requirements of the spinner.

Discussion therefore centres round the relationship between hair properties and yarn properties, the elucidation of which, though seemingly simple, has been found to be so bound up with the ramifications of spinning technique that even now it defies completion. Dr. Balls, however, has made a great step in this direction, and the work that he and his assistants of the Fine Cotton Spinners' Research Laboratories have done during the last ten years has surely blazed the trail for further and more conclusive work to follow.

As has been stated above, although this book describes the results of research and discusses them at length, it is not a collection of research papers, and for that reason will not altogether satisfy other workers in the same field. The mode of presentation has naturally made it impossible to go into detail on many points, and consequently one is always wishing to ask the author questions. Thus, for example, one would very much like to know more about the evidence which has led the author to postulate the existence of the 'drafting wave': and one of the most interesting parts of the book, which deals with the strength gradient of cotton yarns, gives only enough information to whet the appetite. However, we ought perhaps to regard ourselves as fortunate to have anything at all, since it is rarely that the results of research carried out by private organisations are made available to the general public in any form. In this connexion it is interesting to read the chapter in the appendix on the "Researcher's Code," in which Dr. Balls sets forth his own views of the subject.

It must not be thought that the book is monotonous in either its matter or its presentation, for not only has it been necessary in the course of work to branch off on innumerable sidelines in order to establish the reasons for unexpected results, but also the author has a very happy, and sometimes pungent, way of putting forward his views and conclusions, as will be seen on p. 111, where the action of the carding engine is under discussion. He says: "A typical figure which has been quoted to me is that more than a million teeth of the cylinder wire pass over each grain of cotton delivered to the card. Putting this in a different way, we find that any one hair is carded by ten thousand separate wire points; as we have seen that an ordinary hair is about two thousand calibres long, it will be struck five times in every calibre of its length. But this is incredible; it takes two to make a fight, and we may reasonably suspect that the hair dodges that fight."

Altogether there is not a dull page in the book, and it is safe to predict that it will be one of those most referred to by other students of cotton for many years to come. W. E. MORTON.

An Encyclopædia of Agriculture.

Handbuch der Landwirtschaft. Herausgegeben von Fr. Aereboe, J. Hansen und Th. Roemer. Fünf Bände. Band 1, Lieferung 3. Pp. 128. Band 2, Lieferung 4. Pp. 129-256. Band 4, Lieferung 5. Pp. 128. Band 5, Lieferung 6. Pp. 128. Band 2, Lieferung 7. Pp. 257-384. (Berlin: Paul Parey, 1928.) 5·80 gold marks each Part.

THE further instalment is now to hand of the large "Handbuch der Landwirtschaft" being issued under the editorship of Drs. Aereboe, Hansen, and Roemer. The new issues are on the same lines as the others; the 'Handbuch' retains its character of being a collection of monographs on different phases of agriculture, and, as before, the references are in general few, but they are to standard works where the reader would be able to obtain full and authoritative information.

One of the longest sections is by Prof. K. Ritter of Berlin, on the history of agriculture, which practically fills the first part of the first section. This is a remarkable piece of work, comprising, in 120 pages, a summary of the history of agriculture in every important country of the world from the earliest times to the present day, and by the device of using two sizes of type the editors have separated the general paragraphs from those concerned with the details. The author points out that the earliest agriculture was simply concerned with the gathering of wild products: then about 4000 B.C. the sowing of seed was practised, the seed being either pressed in by hand or worked in with a stick. It is not known how or when the plough originated, but the yoke seems to have been first used in Mesopotamia. From very early times oxen were hired to cultivators having none of their own.

The seed drill is a comparatively modern implement, but it is foreshadowed in the ancient Mesopotamian device of sowing seed behind the plough by means of a seed funnel. By about 1100 B.C. iron plough-shares had come in, and the large clods of earth left by the plough were broken up either by means of a mallet or by a primitive harrow;

these methods persisted in Europe throughout medieval times, and indeed they are illustrated in the fourteenth-century Louterell Psalter. The rate of seeding strikes us as thin, being only about 30-55 litres per hectare, or $\frac{1}{3}$ to $\frac{1}{2}$ bushel per acre.

The simultaneous development of agriculture in Egypt is also described at length. A full account is given of Roman agriculture and the influence exerted thereon by Carthage, the home of numerous agricultural developments, particularly of threshing devices. It was from that source that the flail is said to have come, also the roller for separating the grain from the ear; the full story of the indebtedness of Roman agriculture to Carthage still remains, however, to be written.

There is also an interesting discussion of the influence of English colonisation on the agricultural output of the world, giving the point of view of an intelligent onlooker who is sincerely trying to be unbiased. Post-War developments are dealt with at some length, including a discussion of the effects of the great fall in agricultural values which led to such disastrous consequences in England and elsewhere.

In the next instalment Dr. Münzinger completes his account of agricultural meteorology, and Dr. Rothe of Königsberg deals with the control of water supply to the soil by cultivation, irrigation, and other means. In this section also he deals with moor culture, an important part of which consists in the regulation of the water supply and the removal of excess of water by drainage.

Dr. Roemer of Halle discusses cultivation, giving an interesting account of the scientific principles on which it is based, so far as they are at present known, and then going on to describe the various cultivation implements now in use. Great advances remain to be made, both in scientific and practical directions. This is followed by an account of seeds and germination by Dr. Pieper of Dresden, after which Dr. M. v. Wrangell of Hohenheim gives a full account of plant nutrition, in which much recent work is summarised.

The remaining two sections to hand are from the fourth and fifth volumes dealing with problems of animal husbandry. Dr. Hieronymi of Königsberg deals with the anatomy and physiology of farm animals, and Dr. von Falck of Berlin with the more practical aspects so far as the horse is concerned, while Dr. Hansen deals with cattle.

These sections maintain the general character and standard of those formerly noticed, and they strengthen the impression that the complete volumes will be a valuable addition to modern agricultural literature.

Our Bookshelf.

Ceramics: Clay Technology. By Prof. Hewitt Wilson. Pp. xiv + 296. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1927.) 20*s.* net.

CERAMICS occupies a wide field, and in the United States it covers a wider range than in most other countries. Until near the end of the nineteenth century, notwithstanding the improvements introduced by such men as Wedgwood, Brongniart, Seger, and others, much of the work done on most factories continued to be carried out largely by 'rule of thumb' methods. During the present century, systematic research has been brought to bear on the chemical and physical factors on which the qualities of manufactured products must mainly depend; and in the volume under review the author aims at giving a comprehensive survey of the important results of the modern activities alluded to.

The first chapter deals with definitions, and with the classification and description of ceramic products, including pottery and porcelain, glass, enamelled metals, abrasives, cements, refractories, etc. Then follow three chapters treating of the formation of clays, their characteristics (chemical, physical, and mineralogical), with short notices of other raw materials. In the fifth chapter the drying of clay wares is considered at some length, and Chapter vi. is similarly devoted to a discussion of heating effects.

The final chapter (vii.), under the heading "Melting, Fusion, and Crystallisation of Silicates," gives a general account of the thermal phenomena associated with silicate melts, including a concise statement of modern discoveries regarding eutectic action, temperature concentration systems, with the application of the phase rule to silicate mixtures, etc. Conventional diagrams are used freely to illustrate this as well as other parts of the book. Some portions of this last chapter are likely to prove difficult reading to many, but those who have had a good grounding in modern scientific methods will find it both interesting and helpful.

Some valuable research work bearing on the drying of clay wares, by English investigators, in 1927, was unluckily not published in time to find mention in the present volume. A few misprints have been noticed, and exception might be taken to one or two statements worded with less than the usual care, but the book as a whole provides a sound and reliable exposition of the subjects dealt with.

Practical Hints to Scientific Travellers. Edited by Prof. H. A. Brouwer. Vol. 5. Pp. v + 173 + 14 plates. (The Hague: Martinus Nijhoff, 1927.) 5 guilders; 8*s.* 6*d.*

AUTHORS of five nationalities have contributed to the volume now before us, the fifth of its series; of the four articles which it contains, three are in English, but for the first time one is published in German.

Two Swiss geologists, H. Adrian and H. Hintermann, deal with travel in Ecuador, from experience gained on reconnaissance trips in 1924 and 1925. Although they state that their visits were comparatively short, they appear to have gained a good general knowledge of the country, its customs, and means of transport. N. H. van Doorninck and H. J. Schuiling, mining geologists connected with the Union Minière du Haut Katanga, deal with the Eastern Congo in a useful article which supplements that on East Africa, by P. A. Wagner and T. G. Trevor, included in the first volume of the series.

In the introductory section of his article (in German) on northern Manchuria and the Amur and Maritime Provinces of the Russian Far East, E. E. Ahnert has condensed a large amount of detailed information concerning the physical conditions of the region, and illustrates this account by several sketch-maps. Both this information and his review of the progress of the topographical and geological survey of the region should be useful, since much of the literature is in Russian, as shown by his bibliography. Equally detailed is his information concerning suitable equipment, convenient centres for exploratory work, prices, etc. The last article, in which J. B. Scrivenor deals with some aspects of travelling in the Malay Peninsula, is shorter and less detailed than the others.

Handbuch der Pflanzenanatomie. Herausgegeben von Prof. K. Linsbauer. Abteilung 1, Teil 2: *Histologie.* Lieferung 22, Band 5: *Die pflanzlichen Trennungsgewebe.* Von Dr. H. Pfeiffer. Pp. viii + 236. (Berlin: Gebrüder Borntraeger, 1928.) 16 gold marks.

THE separation of plant parts from the parent organs has been much studied in more or less isolated examples, but for the first time the very scattered results have been fully classified and considered as aspects of one subject in the above work. The classification of abscission tissues is under three main headings: the separation of withering or dead organs (including the fall of leaves in autumn, of flower-parts after pollination, and of axial organs), the severing of living parts which continue to function after becoming distinct from the parent (including processes involved in vegetative multiplication and sexual reproduction), and the pathological production of tissues causing the separation of plant-parts. A summary of the general descriptive anatomy of abscission tissues follows their detailed classification.

In an attempt to define the causes underlying the formation of tissues leading to the separation of plant-parts, the author emphasises the absence of general theories and confesses that though partial explanations, especially of an ecological or biological (and, it appears, partly of a teleological) nature, have been suggested, no unifying working hypothesis has yet been obtained. The need for further research in different branches of the subject is often indicated. The work is illustrated with 36 text-figures, and is provided with a list of cited literature, occupying 19 pages, and with indexes.

Photography, its Principles and Practice: a Manual of the Theory and Practice of Photography designed for use in Colleges, Technical Institutions, and by the Advanced Student of the Science. By C. B. Neblette. Pp. xviii + 644. (London: Chapman and Hall, Ltd., 1927.) 30*s.* net.

IT is a considerable time since a text-book of photography was available for college students of the subject, and during that time a large amount of investigation has been carried out, and many interesting and important results obtained. This volume is notable as being the first, at least in the English language, to incorporate these results and present them in a connected manner.

We believe that the author has had considerable experience as a teacher of photography, and being well qualified for the task, he has produced a very praiseworthy work. Being the first edition, and practically a pioneer with regard to the more modern developments, one must not expect that freedom from errors, chiefly typographical, that may very properly be looked for in a subsequent edition. Although it is a large book, of course every item has to be summarised, and there is much scope for variety of opinion as to how the available space shall be divided among the many sections of the subject. We take one example only. The author says that "wet collodion is still unsurpassed for line work," but he does not treat of this process, which is important, for theoretical as well as practical purposes, except in a cursory manner in the general historical introduction. However, we welcome this useful addition to photographic literature.

Vertebrate Embryology: a Text-book for Colleges and Universities. By Prof. Waldo Shumway. Pp. viii + 314. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1927.) 18*s.* 6*d.* net.

AN excellent introduction to the comparative study of embryology, dealing mainly with *Amphioxus*, the frog, the chick, the pig, and man, with a concise but illuminating discussion of the embryological aspects of genetics, and useful technical instructions for making and staining serial sections of embryos. The fact that the book is illustrated by Miss Katharine Hill (Mrs. Paul) confers upon it its outstanding distinction. The figures are so clear and diagrammatic as to be self-explanatory.

Notes on some Birds of Dar es Salaam. By Cecily J. Ruggles-Brise. Pp. xviii + 96 + 20 plates. (Norwich and London: Jarrold and Sons, Ltd., n.d.) 4*s.* 6*d.* net.

MISS RUGGLES-BRISE in this little book gives quite an interesting account of many of the common birds of the provinces about which she writes. It is true that we shall be disappointed if we expect to obtain any new information or any matter of scientific interest; but visitors to this part of Africa will find the book will help them to name some of the birds they see. The pen sketches of the birds are rather crude, but the few photogravures are quite charming.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Action of Light on Celluloid stained with Malachite Green.

IT has been shown by Pettit (*Astrophys. J.*, vol. 64, p. 43; 1927) that green celluloid on prolonged exposure to the sun turns dark, and transmits only deep red and infra-red rays. He states that "the transmission curve for this solarised green celluloid is practically identical with that of ordinary green celluloid in the infra-red from λ0·7 to 2·0 μ, the transmission bands in the green λ0·50 μ and ultra-violet λ0·36 μ being completely suppressed. This solarised celluloid forms the only screen to the writer's knowledge which has a sharp cut off at 0·7 μ, transmits no radiation from this point to λ0·23 μ and transmits the infra-red beyond λ0·7 μ with an efficiency of 80 to 90 per cent."

My interest was aroused by this observation primarily because I wished to make use of such a screen, but I have been led on from this to investigate the action of sunlight on green celluloid more closely.

Mr. Pettit most kindly sent me a specimen of the green celluloid which he uses, and also a finished filter made up of three superposed layers of the solarised material. I was able to obtain a similar green celluloid of rather paler tint in England, which showed the same reaction towards sunlight, and on inquiry of the makers they informed me that the colouring matter was the aniline dye called malachite green.

It was found that the green celluloid, after darkening to a certain extent without much obvious change of tint, turns bluish, then plum-coloured, and then deep red. The red colour becomes lighter, and finally fades away, leaving the celluloid almost colourless. The intermittent character of sunshine in England makes it difficult to give any definite statement as to how long these changes take to run their course, but probably the equivalent of a month's continuous sunshine is required with the celluloid I used. Naturally, the changes are slower the greater the amount of colouring matter initially present, for the outer layers must tend to screen off the effective radiation from the inner ones. For the same reason it is advisable to expose each side alternately.

Now what view is to be taken of these changes? It appears that the green colouring matter initially present is gradually converted by the action of light into a substance transmitting red only. During the intermediate stages these colouring matters are present together, and their combined action absorbs all visible light except the extreme red, which is transmitted by both. Eventually all the malachite green is converted into the red substance, which transmits much more red light than the former, but is opaque to the rest of the spectrum.

The diagrams of absorption spectra given (Fig. 1) illustrate this change. They are from visual measurements of the limits of transmission made with a small diffraction spectroscope with micrometer. The position of the limits is not of course so definite as here diagramatically indicated, and the positions depend to some extent on the density of colour in the celluloid used. The transmission regions are indicated in black: *A* is the transmission of the celluloid alone as purchased, *B* of the red celluloid obtained by prolonged exposure, *C* of the intermediate stage, when both the varieties are present, and the transmission is only of the deep red portion which can pass both.

Evidently we could obtain the same effect by combining a red or orange commercial gelatine film filter with the untreated green celluloid, which might be cemented to it. Probably this is the readiest method of making up an infra-red filter, though I have not investigated its efficiency beyond the limit of ordinary panchromatic plates. It is true that in this case we give up the advantage of using a single filter, which may be secured by using the solarised celluloid. (A mixture of unaltered malachite green and a ready made orange dye in celluloid or gelatine would probably secure the same result.)

I have found that the same change from green to red may be quickly produced without sunlight by heating the green celluloid on an electric hot plate. A rather high temperature is required, and care is necessary to avoid raising it too high, which blisters the surface.

The reddened celluloid may be dissolved in amyl acetate to form a red solution.

The experiments described so far were made with commercial green celluloid. But they raise various questions of interest the answers to which could perhaps be found in technical literature, but which I have investigated *de novo* with home-made prepara-

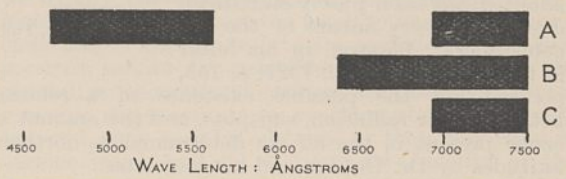

FIG. 1.

tions. In the first place, crystals of malachite green were dissolved in celluloid varnish (celluloid in amyl acetate), and the varnish thus coloured was poured out on glass plates and allowed to dry. Coloured films so prepared were exposed to the sun, and were found to go through the same sequence of colour changes as the commercial green celluloid. I suspected that the home-made films were somewhat more quickly darkened than the commercial celluloid, but strictly comparative tests with the same initial density of colour have not been made.

Next, a clear gelatine film was prepared from an ordinary photographic plate, which was fixed, washed, and dried. This was stained with an aqueous solution of malachite green, dried, and exposed to the sun. Although its initial appearance was very similar to that of the celluloid film stained with the same sample of dye, the behaviour under exposure was strikingly different. For whereas the celluloid film becomes darker, the gelatine film becomes lighter on exposure. There is no reddening of the gelatine film, which fades in the ordinary way. The green colour becomes paler, but the film remains green so long as any colour survives.

Films prepared by simply flowing an aqueous solution of the dye on glass behave in the same way as the gelatine film, the colour progressively fading away without change.

These various experiments seem to prove very definitely that the production of the red substance in green celluloid is due to a specific action of the celluloid, which latter acts not merely as a medium to hold the dye, but as a chemical reagent. Celluloid contains nitrocellulose and camphor. It appears that the former constituent is alone necessary for

producing the red substance. An old sample of nitrated cotton was dissolved in alcohol-ether, and a few crystals of malachite green added. Glass plates were coated with this mixture, and went red on heating or on exposure to an iron arc. For lack of sunshine I have not been able to carry the change to the red stage with this agent, but the initial darkening has been observed in diffuse daylight. On the other hand, nothing analogous can be observed with camphor.

RAYLEIGH.

Terling Place,
Chelmsford, Oct. 17.

Long Wave Radio Reception and Atmospheric Ozone.

FOR some time past, efforts have been continuously made to find out the relation between the signal strength of distant radio stations and magnetic and meteorological elements of the earth. The results obtained by Austin and Pickard have shown that there is some connexion between radio reception and solar phenomena, such as those due to the spots on the sun. The method adopted has been purely statistical, due to the very nature of the circumstances. Clayton, in his letter in NATURE of July 30, 1927, p. 153, pointed out the possible existence of a relation between solar radiation, sunspots, and the amount of ozone present in the air, as determined in northern latitudes by Dr. Dobson and his associates.

A comparison between radio reception and the ozone content naturally suggests itself in view of the ionising properties of the gas. This would be specially marked at sunrise and sunset, when very considerable changes in ionisation take place followed by changes in intensity and polarisation of radio waves. Unfortunately, there are at present no means of measuring the degree of ionisation of atmospheric ozone and its hourly changes. Perhaps field strength measurement of received radio signals afford some information thereon.

Since March 1926, measurements of the received field of Madras (Fort) Radio on 75 kc./sec. have been made on a special test transmission of a long dash at 0800 I.S.T. at the Radio Laboratory of the Indian Institute of Science, Bangalore, with apparatus closely following the description given by Hollingworth (*J.I.E.E.*, vol. 61, p. 501). Dr. Dobson very kindly supplied the revised mean daily ozone values for north-western Europe for the periods July–September 1926 and March–October 1927. The period common to both measurements is the six months March–August 1927.

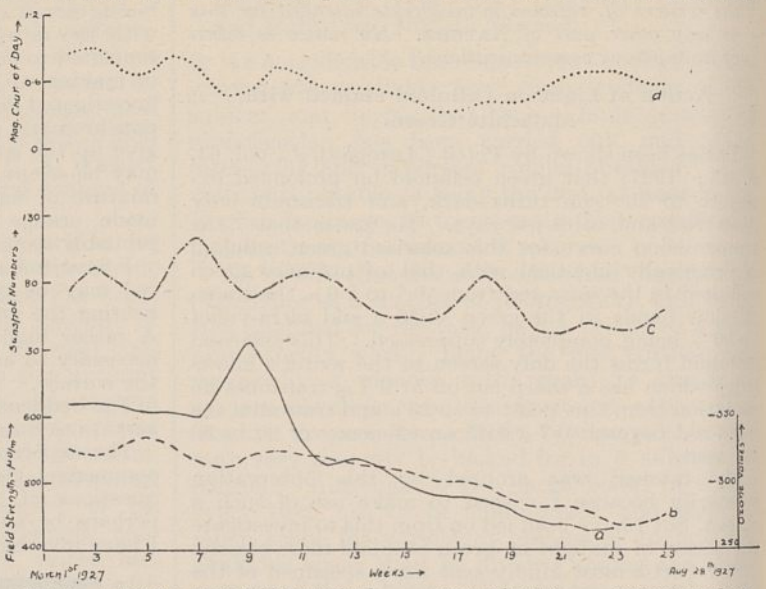

FIG. 2.—*a*, Full line, radio field strength; *b*, ----, ozone values; *c*, – · – ·, sunspot numbers; *d*, ..., magnetic character of day.

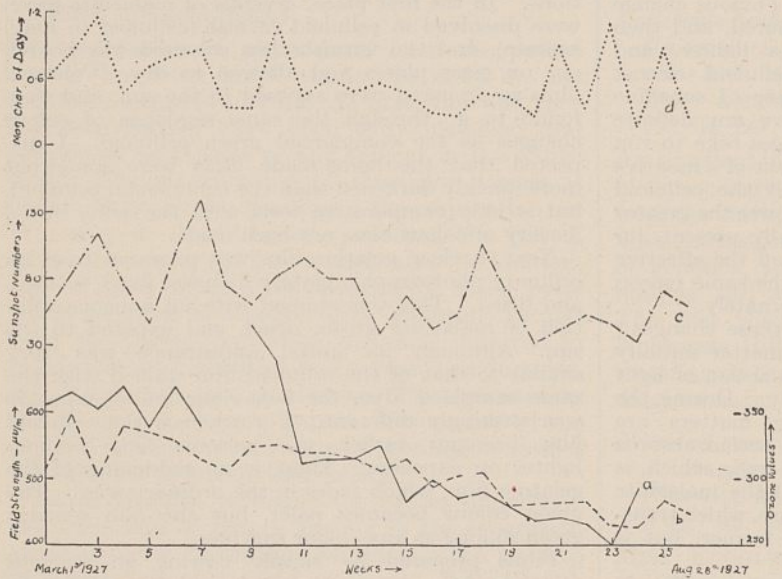

FIG. 1.—*a*, Full line, radio field strength; *b*, ----, ozone values; *c*, – · – ·, sunspot numbers; *d*, ..., magnetic character of day.

The curves *a* and *b* in Fig. 1 show the weekly averages of ozone values and field strength. The similarity between them is not pronounced during March and April; later on, however, they both decrease steadily and at about the same rate. The greatest divergence occurs in the ninth and tenth weeks, when signal strength shoots up to about 150 per cent of the average for the whole period. To bring out the chief similarity by taking away the comparatively transient changes, the smoothing formula $\frac{x+2y+z}{4}$ has been used giving the curves *a* and *b* in Fig. 2. These run almost parallel to each other after the eleventh week, and roughly so between the second and seventh weeks. The reason for the comparatively sharp rise and equally sudden fall of signal strength during the ninth and tenth weeks is not understood. Neglecting the values of field strength for these two weeks, the correlation between field intensity and ozone works out as $1{\cdot}77 \pm 0{\cdot}23$, which is very satisfactory considering the nature of the phenomena.

The curves show definitely that long wave field intensity is proportional to the ozone value of the air

even when the averages are taken over such short periods as a week. From the ionisation theory of radio wave propagation, so far as it is understood, it looks as though the reverse should be true with propagation of very high frequency waves, say above 3×10^6 cycles per second.

The relation with sunspot activity is not so pronounced though fairly definite. Curve *c* in Fig. 1 represents the weekly averages of sunspot numbers due to Dr. Wolfer; in Fig. 2, *c* refers to the smoothed values. With little similarity in details, and with the exception of the peak in sunspots corresponding to the eighteenth week, the general tendency for a continuous decrease is evident; curve *c* brings this out a little better.

On the other hand, there seems to be no tangible connexion between terrestrial magnetism as given by the international numbers for the mean magnetic character of day; the curves corresponding to this are marked *d* in Figs. 1 and 2. Support is gradually gathering for the view that a definite relation between sunspots and magnetic storms is yet to be found; violent variations of one are not always followed by corresponding fluctuations in the other. But the importance in connexion with this note lies in the fact that one would expect a magnetic storm to be preceded or followed by some abnormality in reception. This certainly does not seem to be the case with the Bangalore observations on Madras, even over longer periods than March–August 1927.

The close correlation between ozone and reception on 4 km. wave-length is to some extent remarkable in view of the great distance, at least 8000 km., separating Bangalore and Madras from the stations in north-western Europe where the ozone values have been observed. The direct and almost inevitable conclusion is that changes in the ozone values partake of the nature of a world phenomenon. Further, the existence of this gas at a height of about 30 to 40 km. is of additional interest in view of the fact that according to some estimates, long radio waves are supposed to penetrate up to about 40 to 50 km.

It is worthy of note that an increase or decrease of sunspot activity as indicated by Wolfer's numbers does not seem to be followed always by corresponding variations in ozone or field intensity. This, along with the absence of any definite relation between sunspots and magnetic storms, lends support to the explanation offered; either that the sunspots are not all equally active in the emission of charged particles or that those emitted by some do not reach the earth's atmosphere.

The relation, over moderate distances, between temperature and long wave propagation is fairly definite. The observations on Madras show some measure of agreement with Austin's conclusion of a negative correlation between them. This is not surprising, as the temperature changes both at Madras and Bangalore are markedly similar, indicating a common cause in the upper regions of the atmosphere.

Examination of barometric pressure changes have given no information of any value.

A detailed report is to be published at an early date. It would, however, be of interest to know if other investigators have discovered any relation in this connexion.

I am indebted to the Astronomer Royal and Dr. K. R. Ramanathan for the magnetic data and to Dr. Dobson for the ozone values. My thanks are due to Prof. J. K. Catterson-Smith for permission to send this letter.

K. SREENIVASAN.

Somerton, Aug. 23.

Definition of 'Area' in Contact Catalysis.

IT is evident that the apparent area of an irregular surface will depend on the size of the object used for measuring it. This has been clearly expressed by Constable (NATURE, Sept. 15, p. 399), the 'maximum' area of a surface being defined as that of "the envelope of the monatomic film of hydrogen atoms closely packed, all in contact with each other and with the catalyst, and completely covering it." This, as an arbitrary definition of area, is a useful one, though it is questionable whether it has any real physical significance, the work of Davisson and Germer on the diffraction of electrons indicating that the packing of gas atoms adsorbed on a metal surface follows that of the metal atoms in the crystal lattice.

However, in studying the catalytic properties of a surface for a particular reaction, the area which is of most interest is not this arbitrarily defined 'maximum' area, but is rather that area of the catalyst which can be reached by the particular reactants considered. For example, in studying the electrolytic deposition of hydrogen ions at the surface of a metallic cathode, the area to be considered is that area which is accessible to the hydrogen ions and on which they can deposit or be adsorbed, and this has been defined (Bowden and Rideal, *Proc. Roy. Soc.*, A, **120**, 80; 1928) as the 'accessible area' for this particular reaction. In this case it is limited by the area of the metal which is wetted by the electrolyte, and irregularities in the metal surface which are too small to be penetrated by molecules of the electrolyte are excluded since these portions cannot be available for the reaction. In general, since catalytic surfaces are probably heterogeneous, the reactants on reaching the surface may rebound, they may be adsorbed or they may react in various ways, and in studying the kinetics of the system or comparing the catalytic activity of two surfaces it is a knowledge of this 'accessible area' which is likely to be of the most interest.

Last year, during a general study of hydrogen deposition, a method was evolved for the measurement of the areas of metallic surfaces by the electrolytic deposition of hydrogen from solution (*Proc. Roy. Soc.*, A, **120**, 59) and was then outlined to Dr. Constable in this laboratory. When some months later, in a footnote added to a paper (*Proc. Roy. Soc.*, A, **119**, 197; 1928), he referred to the possibility of such a method being used, it was naturally assumed that he referred to this. The assumptions made are of course fully discussed in the original paper, and it may be seen that there is considerable experimental evidence for them. It has been stated (Constable, NATURE, Sept. 15, p. 399) that in this method the hydrogen covers only a small fraction of the surface; but it should again be pointed out that the quantity measured is the amount of hydrogen *added* to the surface in order to cause a given change in the electrode potential. This quantity is small, but it does not follow from this that the hydrogen is sparsely distributed over the plate since the initial surface concentration of hydrogen is not known with any certainty. In fact there is some evidence from surface tension data that at the potential of the reversible hydrogen electrode a large proportion of the accessible metal atoms are already covered with hydrogen.

The amount of hydrogen present on the surface per unit of 'accessible area' is a reasonable definition of its surface concentration, and this has been called the 'true surface concentration of hydrogen' in order to distinguish it from the apparent concentration. Using this method, the rate at which the surface catalyses the deposition of hydrogen ions can be investigated simultaneously with the measurement of the area

which is accessible to the hydrogen ions, and the effect of different methods of treatment of the metal surface on both these factors can be studied.

It is probable that the catalytic activity of a surface depends mainly on the first few atomic layers, and it is the nature and configuration of these surface atoms which are of most interest in contact catalysis. It would seem possible that the electrolytic method can give some information as to the 'area' and properties of these surface atoms. In the interference method, the metal is heated in oxygen until an oxide layer is formed of sufficient thickness to be visible by interference colours. Making assumptions as to the optical properties of the surface and the chemical composition, density, and homogeneity of the oxide layer, its 'area' can be calculated. This method, which has been developed by Constable (*Proc. Roy. Soc.*, A, **119**, 197; 1928), is a valuable one, capable of giving interesting information of the structure of thin metallic films, but since it necessarily involves the destruction of the metal surface to a depth of some thousand atoms, the information it can give as to the 'area' and configuration of the initial surface atoms is limited. Also, since it disregards the fine structure of the metal surface (inequalities less than 10^{-5} cm. being ignored), it is to be expected that it would give a value for the 'area' which is less than that of the metal surface accessible to hydrogen ions from solution, and experimentally this is found to be the case. The surface which has been measured by the oxidation method is nickel, and the 'area' found for the activated metal varies from 1·3 to 4·5 times its apparent area. By the electrolytic method the 'accessible area' of rolled metal may be from two to five times its apparent area, for sand-papered metal approximately ten times, and in the case of nickel, activation by alternate oxidation and reduction causes an increase to forty-six times its apparent area.

F. P. BOWDEN.

Laboratory of Physical Chemistry,
Cambridge, Sept. 24.

Vitamin-D and Iso-Ergosterol.

IN connexion with the problem of the constitution of vitamin-D, the following comparison of the absorption spectra of irradiated ergosterol and of unirradiated iso-ergosterol is of interest.

Fig. 1 gives the photometric curves [1] of the spectra of (*a*) 0·01 per cent alcoholic solution of ergosterol,

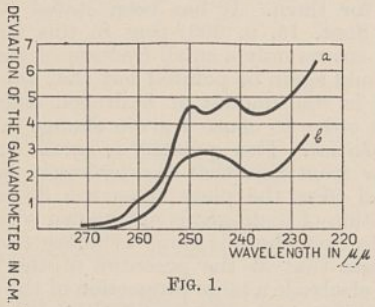

FIG. 1.

irradiated in such a manner that the absorption in the region of 270-300 $\mu\mu$ has disappeared, and has given place to a rather strong absorption with a maximum at about 247 $\mu\mu$. This phenomenon is shown in the literature to be characteristic for the formation of vitamin-D.[2,3] (*b*) 0·008 per cent alcoholic solution of iso-ergosterol.

The absorption spectra were taken with a discharge tube emitting the continuous hydrogen spectrum as light-source. When the absorption tray is filled with alcohol, this light-source gives with our spectrograph and plates an absolutely constant blackening of the plate in the region 300-245 $\mu\mu$. For shorter wave-lengths the blackening falls off, first slowly, then more quickly, in proportion as the sensitivity of the plate diminishes. A comparison of the two curves shows immediately that they have the same character. This is clear from the similar shape of their basis-curves. Only curve (*a*) shows in addition three little peaks at wave-lengths 262, 250, 242 $\mu\mu$. This is a very interesting fact, as two of these bands, at 262 and 250 $\mu\mu$, exist already in the absorption spectrum of unirradiated ergosterol. This is shown by Fig. 2, which gives

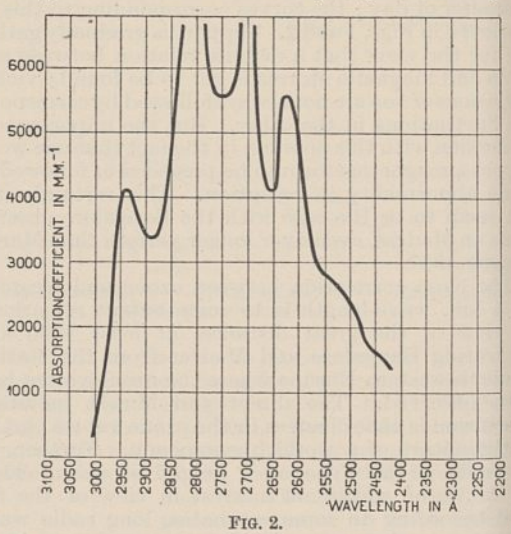

FIG. 2.

the absorption coefficient of unirradiated ergosterol as a function of the wave-length. In this figure these two bands are clearly visible. These bands, contrary to the three longer bands of unirradiated ergosterol, do not decrease in strength by irradiation.

These facts suggest the following hypothesis: the ergosterol has two types of absorption bands, connected with different parts of the molecule. By irradiation such that vitamin-D is formed, the first system ($\lambda_1 = 293_5$, $\lambda_2 = 281_3$, $\lambda_3 = 270_9$) makes way for the characteristic absorption band of iso-ergosterol, which would mean that the corresponding part of the molecule undergoes the same change in constitution by irradiation as by the transformation of ergosterol into iso-ergosterol by the chemical method of Reindel.[4] Another part of the molecule obviously does not change its constitution. This follows from the permanence of the second system of bands ($\lambda_4 = 262$, $\lambda_5 = 250$). The meaning of the peak at $\lambda_6 = 242$ $\mu\mu$ is not yet elucidated.

Like vitamin-D, the iso-ergosterol remains unchanged by irradiation with ultra-violet light of wave-length longer than 270 $\mu\mu$, and is destroyed by light of wave-length of about 250 $\mu\mu$, as is shown by the disappearance of the absorption bands.

A. VAN WIJK.
E. H. REERINK.

Natuurkundig Laboratorium der
N. V. Philips' Gloeilampenfabrieken,
Eindhoven, Sept. 18.

[1] It must be noted that in the curves (Fig. 1) only the transmission of the photographic plates in relation to the wave-length is given, and not the absorption coefficients themselves. These will be published in due course, when the whole material has been worked out.

[2] For example, Heilbron, NATURE, vol. 120, p. 617; 1927.

[3] A study concerning the change in the absorption spectra of ergosterol and other substances by irradiation with different wave-lengths is in progress, and will shortly be published in full.

[4] Reindel, *Lieb. Ann.*, vol. 452, p. 34; 1927.

The Magnetic Moment of the Electron.

THE hypothesis of the spinning electron assigns to the electron an angular momentum $h/4\pi$ and a magnetic moment $eh/4\pi mc$. Dirac [1] showed that the spectroscopic duplexity pointed out by Heisenberg can be explained more satisfactorily by modifying the wave equation. In his theory the angular momentum is still $h/4\pi$. The magnetic moment μ, however, is only approximately the Bohr magneton μ_0. Using Darwin's [2] explicit expressions for the four ψ's, the magnetic moment of the electron in the field of a charge Ze is easily calculated. The result is

$$\mu = \mu_0(1 + 2\sqrt{1 - \alpha^2Z^2})/3,$$

where α is the fine structure constant $7{\cdot}3 \times 10^{-3}$. Substituting $Z = 92$ for uranium, we obtain $\mu = 0{\cdot}83\mu_0$.

Since in the nucleus there may be very intense fields, the conditions in it are approximated by using large values of Z. The highest value that may be used is 137, because higher values make the solution inapplicable. For this Z the moment decreases to $(1/3)\mu_0$. Performing the same calculation for excited states with radial quantum number = 0, we find, using Darwin's notation and his first type of solution,

$$\mu = (1 + 2\sqrt{(k+1)^2 - \alpha^2Z^2})(2k+3)^{-1}\mu_H,$$

where μ_H is the ordinary magnetic moment of the state in question calculated neglecting relativity. The theoretically possible minimum of the above expression is $(2k+3)^{-1}\mu_H$. Thus in intense fields such as may exist in the nucleus, the magnetic moment of the electron may be less than a Bohr magneton.

Dr. R. S. Mulliken pointed out to me that in several instances isotopes supposedly containing odd and even numbers of nuclear electrons have practically identical spectra. If the magnetic moment of the electron were always μ_0 one of the two isotopes would have a resultant nuclear magnetic moment which would modify its spectrum very noticeably. Therefore he concluded that for the nuclear electrons μ may be much smaller than μ_0. Dirac's theory is qualitatively at least in agreement with this conclusion of Mulliken. It shows that the electron spin can be modified by the presence of intense electric fields, and that in the cases mentioned above the magnetic moment is smaller than a Bohr magneton.

Barnett's [3] and Emil Beck's [4] measurements of the gyromagnetic ratio gave in contradiction to those of Chattock, Sucksmith, and Bates [5] a value which indicates a somewhat smaller μ than would correspond to a Bohr magneton. There may be other reasons for this than the dependence of μ on the type and strength of the field. This may be, however, one of the reasons. A central field of the order of about $50e$ corresponds to the observed deviation.

G. BREIT.

Department of Terrestrial Magnetism,
Carnegie Institution of Washington.
(Temporarily in Zurich.)

The Depth of Field and Resolving Power of Optical Instruments.

THE belief of some physicists that the significance of Airy's work of a hundred years ago on the character of optical images is rarely appreciated by users of optical instruments, will be strengthened by a recent letter in NATURE. It calls to mind a statement in Lord Rayleigh's address to the Royal Society in 1907: "In looking into the more recent progress of Geometrical Optics, I have been astonished to find how little correlation there has been. . . . In this subject it would appear that a man cannot succeed in making even his own countrymen attend to him." Lord Rayleigh himself appears to have fared no better than his great predecessors. More than forty years ago he discussed, in terms of the wave theory, the accuracy necessary in focussing, and verified his theory by experiment. Nevertheless, so far as I can recall, every book on optics or photography that deals with this question bases the discussion on the geometrical theory. The tables for finding depth of field published each year in the *British Journal Photographic Almanac*, and a recent contribution to NATURE, rest on the same assumptions.

Unfortunately, the geometrical method has a habit of returning the wrong answer to questions affecting the use of optical instruments. It leads us to expect an improvement in the definition given by a lens when the aperture is diminished, but the wave theory leads to the opposite conclusion. It declares that the depth of field should vary inversely as the first power of the diameter of the aperture, but the wave theory substitutes the second power. These two examples, out of many that might be cited, show the importance of considering optical questions in accordance with the concepts of the wave theory. The geometrical method, if employed at all, should only be used to find relations between loci where perfect ray convergence may be assumed. When tolerances are discussed by the wave method, it turns out that the quantities involved are invariants as found by this restricted geometrical method. The reason for this correspondence becomes clear when the wave theory is employed throughout; it will be sufficient here to give examples.

If y is a small length perpendicular to the axis, meeting it in the same point as a ray inclined at an angle θ with the axis, $\mu y \sin\theta$ is invariant on refraction if this elementary length is imaged without aberration. The parallel theorem states that two points in the same transverse plane will not appear distinct in the image if their separation y is less than the value which satisfies $\mu y \sin\theta = \kappa\lambda$, where κ is a constant and θ is the inclination to the axis of the extreme ray transmitted by the lens. If x represents a small length measured along the axis of the lens, the invariance of $\mu x(1 - \cos\theta)$ corresponds to a range of focus x, determined by the condition $\mu x(1 - \cos\theta) = \kappa'\lambda$, within which the minimum standard of definition depends on the constant κ'. For sensibly perfect imagery κ' should not exceed 1/4. In most photographic work values as high as 4, or even 8, are generally accepted as the equivalent of good definition. Except with high power microscope lenses, $\sin\theta$ and $1 - \cos\theta$ may be replaced by $a/2u$ and $a^2/8u^2$ respectively, where a is the diameter of the aperture and u is the distance from the lens of the point from which the elementary displacements x and y are made.

A third law of geometrical optics, which is in effect a combination of the two just mentioned, states that the longitudinal magnification is proportional to the square of the transverse magnification; in symbols, $x/\mu y^2$ is invariant. The related theorem is that the depth of field associated with the distinct rendering of points distant y apart is x, where $\lambda x = K\mu y^2$, K being a constant depending on the quality of definition considered satisfactory. Evidently $K = 2\kappa'/\kappa^2$, and sensibly perfect definition, with the central diffraction discs of distinctly rendered points in contact, is attained with $K = 1/3$.

In all these expressions λ is the wave-length of the light forming the image, measured in the medium for

[1] P. A. M. Dirac, *Proc. Roy. Soc.*, A, vol. 117, p. 610; vol. 118, p. 351.
[2] C. G. Darwin, *idem*, vol. 119.
[3] S. J. Barnett, *Proc. Amer. Acad.*, vol. 60, p. 127.
[4] Emil Beck, *Ann. der Phys.*, vol. 60, p. 109.
[5] Sucksmith and Bates, *Proc. Roy. Soc.*, vol. 104, p. 499; [vol. 108, p. 638.

which the refractive index is taken as unity. Thus if points a thousandth of an inch apart, with a total depth of a tenth of an inch, were to be photographed, the value of K would be 1, and with a perfect lens the definition might be estimated as very good. The attainment of a very good negative would depend on obtaining a large enough image to make the tendency of photographic images to spread negligible. The sounder practice, though not always possible on account of the space required, appears to be to obtain a picture of the largest size required in a single operation, and not, as has been suggested, the subsequent enlargement of a small original negative.

T. SMITH.

National Physical Laboratory,
Teddington, Middlesex.

WITHOUT entering into a discussion of the correct interpretation of high power microscopic images, which is a very recondite subject, I should like to point out that Mr. Mallock's statement in NATURE of Oct. 13 that an object of alternate opaque and transparent lines cannot be separated by any method if their spacing is much less than a wave-length, is not confirmed by experience. Lines of this nature on the surface of etched steel have been photographed by visual light, which are not more than 1/140,000 of an inch in their spacing, and can also be seen when approximately of this size. There is some evidence to show that lines nearly twice as fine can be photographed by ultra-violet light of wave-length 1850.

May I direct Mr. Mallock's attention to a short note on diatom structure in the *Journal of the Royal Microscopical Society*, vol. 42, pp. 338-339, which indicates another interpretation of the results which he attributes to a lenticular structure in the object observed.

CONRAD BECK.

69 Mortimer Street, W.1, Oct. 15.

Influence of Temperature on the Raman Effect.

As has been emphasised by Prof. Pringsheim in his recent admirable report on the Raman effect (*Die Naturwissenschaften*, Aug. 3, 1928), there is a far-reaching and fundamental analogy between the behaviour of electrons and of light quanta during their collisions with material particles. The new lines appearing in the spectrum of the scattered light are the result of inelastic collisions or of super-elastic collisions of the light quanta with the molecules of the medium, according as the shift of frequency is towards longer or shorter wave-lengths. As has already been pointed out in an earlier communication (NATURE, July 7, 1928, p. 12), the lines with enhanced frequencies are usually of much smaller intensity than those degraded in frequency to an equal extent. The natural explanation of this is that comparatively few molecules are normally present in an excited state and therefore in a position to communicate energy to the light quantum. As the temperature rises, we should expect the number of such molecules to increase, and the proportion of super-elastic to inelastic collisions to rise *pari passu*.

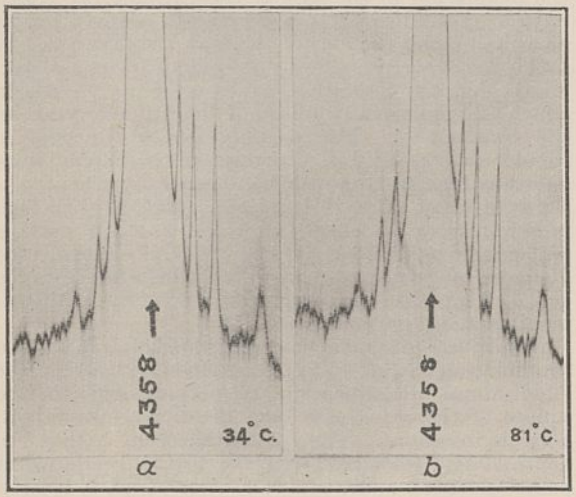

FIG. 1.

The case of carbon tetrachloride is very suitable for an experimental test of this point, as there are numerous Raman lines with relatively small shifts of frequency in its scattered spectrum. I have made experiments which confirm this theoretical expectation. Figs. 1*a* and 1*b* are microphotometric records of the Raman spectrum of carbon tetrachloride excited by the 4358 group of the mercury arc, the former being taken at 34° C. and the latter at 81° C. It will be seen that the lines of higher frequency (towards the left) increase in intensity and those of lower frequency (towards the right) decrease in intensity when the temperature is raised.

K. S. KRISHNAN.

210 Bowbazar Street,
Calcutta, Sept. 6.

Elastic Constants of Single-crystal Aluminium Wire.

IN connexion with my investigations on certain elastic properties of solid metallic elements, Prof. H. C. H. Carpenter, of the Imperial College of Science and Technology, South Kensington, has had made for me single-crystal aluminium wires of diameters 1 mm. and 2 mm. respectively. The wires were drawn down from a single-crystal bar of diameter 0·564 inches and about 4 inches in length.

As a result of a series of carefully conducted experiments, it is found that for these specimens of wires $y = 6{\cdot}779 \times 10^{11}$ and $n = 2{\cdot}432 \times 10^{11}$ (temp. 28°–28·5° C.). The first of these two elastic constants is determined with the help of a sensitive form of extensometer responding to elongations with a few tenths of a gram; and the second, by setting suitable lengths of the wires into torsional vibrations in an air-free chamber. It will be seen that these moduli for single-crystal wires are slightly less than for ordinary specimens.

G. SUBRAHMANIAM.

Vizianagaram, India, Sept. 20.

Geological Jargonese.

THE correspondent on the above subject in NATURE of Oct. 13 gives expression to a matter of regret for many a lay reader like myself, but that regret should not be sharpened by impatience.

NATURE is a kind of mixed grill, prepared for people of widely different tastes, all of them epicures. Though your lay readers may frequently wish that they could fully understand some of the articles that are written, it should not be forgotten that the real use of NATURE is as a medium of exchange of technical information on subjects embracing the whole field of science, and it is obvious that if the geologist were to choose his language to suit the chemist, or vice versa, the value of his contribution might very well be destroyed.

If voracious feeders will consume mixed dishes, they must not complain if some of the ingredients do not suit their palate.

J. P. C. DONE.

Cricklewood, N.W.2.

Phosphorescence, Fluorescence, and Chemical Reaction.[1]

By Prof. E. C. C. BALY, C.B.E., F.R.S.

ONE of the most important theories brought forward during recent years is that known as the radiation hypothesis, which was developed independently by Perrin and by W. C. McC. Lewis. Briefly stated in an elementary way, this theory postulated that molecules in general have no chemical reactivity, and that they become reactive after they have absorbed energy. In order that a specific reactivity be induced, a definite quantity of energy must be supplied to bring each molecule from its initial stage to its reactive state, this quantity being called the critical increment of energy characteristic of the specific reaction.

The Einstein law merely states that in a photochemical reaction a molecule absorbs one quantum of radiant energy, $h\nu_0$, and then becomes activated, no assumption being made as to the difference in energy content of the initial and reactive states. The radiation hypothesis states that the difference in energy content of the initial and reactive states, or the critical increment of activation, is a single quantum which can be absorbed from infra-red radiation. The critical increment of energy characteristic of a reaction is neither expressed nor implied in the Einstein law.

It is a simple matter to calculate the critical increment of a reaction from the observed change of the velocity constant with temperature, and to obtain the critical frequency ν. Not only must this frequency be one characteristic of the reactant molecules, that is to say, one that can be observed by absorption spectra measurements, but the radiation hypothesis also demands that exposure of the inactive molecules to radiant energy of that frequency should cause the reaction to take place. As a matter of experimental fact, molecules in their inactive states do not show any evidence of being characterised by frequencies equal to those calculated from the critical increments. This in itself is sufficiently significant to arrest attention, but when it was proved first by Lindemann and then in most elegant fashion by G. N. Lewis that molecules do not react when exposed to radiant energy, not only of the calculated frequency but also of a very large range of infra-red frequencies, it was felt on all sides that the radiation hypothesis had been effectively and completely disproved.

The situation thus reached is one of considerable interest. There exist on one hand large and increasing numbers of photochemical reactions which are obviously stimulated by the absorption of radiant energy. If the Planck theory stand fast, the reactant molecules must be activated by the absorption of the energy quanta $h\nu_0$, since it is well known that the frequency ν_0 is characteristic of them. On the other hand, the radiation hypothesis is based on premises which appear to be theoretically sound; nevertheless, it has been proved to be untenable. As a result the general consensus of opinion has swung over to activation by collision in thermal reactions. It must, however, be confessed that the present position is very far from being a satisfactory one. In the case of true photochemical reactions, it is not possible to believe that activation of the reactant molecules is not produced by the direct absorption of radiant energy. In the case of thermal reactions, the evidence disproves the activation by the direct absorption of radiant energy, and activation by collision has been substituted.

When the obsequies of the radiation hypothesis had been sung, it was felt that the corpse had received decent burial. I venture to point out that this hypothesis may be divided into two parts. The first part is concerned with the critical increment of energy of a reaction, that is to say, the minimum quantity of energy, or rather the exact quantity of energy, which is required to bring a molecule from its initial state to its reactive state. Unless the whole conception of different molecular states be dropped, this conception of a critical increment stands on a sure and firm basis. The second part of the hypothesis, namely, that the critical increment can be absorbed as a single quantum of energy by a reactant molecule, is a pure assumption and one that would only be justified by a knowledge that the properties of molecules are in this respect identical with those of elementary atoms. The uncertainty which attaches itself to this assumption impresses me so strongly that I propose to exhume the body in order that the cause of death may be more fully investigated.

So far as the phenomena of chemical reaction can help us, our knowledge of the physical properties of molecules, and in particular their change from one to other states of energy content, is singularly meagre, and it would seem that little more can be gained in this direction even by the most intensive study of purely chemical processes. I venture to stress this point of view because I believe that the necessary evidence can only be gained from sources of information which are independent of the processes we wish to explain. Such independent sources of information may be found in the phenomena of phosphorescence, fluorescence, and absorption spectra of compounds.

The term phosphorescence is a broad one and includes both photoluminescence and cathodoluminescence, together with certain subsidiary phenomena. The only one of these that can serve our present purpose is photoluminescence, since a knowledge is essential of the frequency of the activating radiation as well as that of the emitted radiation.

Lenard and Klatt established the very important fact that phosphorescent emission is not a truly reversible process. It is only possible to activate a phosphore by means of radiant energy of the same frequency as that of its characteristic absorption band, which lies on the short wave-length side of the

[1] From the presidential address to Section B (Chemistry) of the British Association, delivered at Glasgow on Sept. 6.

characteristic emission band. These investigators proved the complete validity of Stokes's law, and as the result of later work on true phosphorescence, this law has been proved invariably to hold.

The importance of this may at once be recognised if the facts be stated in more scientific phraseology. When an activated phosphore is emitting its characteristic luminescence, each activated molecule radiates a single quantum of energy in passing from the higher energy state to the lower energy state, the total luminescence being the sum of all these radiated quanta. In the process of activation the change from the lower to the higher state is caused by the absorption of that same quantity of energy by each molecule, and in view of the radiation as a single quantum it is legitimate to assume that it is absorbed as a single quantum, nothing being expressed or implied as to the mechanism of the absorption. Each molecule, therefore, requires for its activation a critical quantum of energy $h\nu_1$, and the value of ν_1 may be directly obtained from the measurement of the luminescence. The proof given by Lenard and Klatt and by others that Stokes's law is valid indicates that it is impossible to activate a phosphore by means of radiant energy of the frequency ν_1, and that the critical quantum of activation cannot be supplied to a molecule by a singular absorption process. There exists, therefore, in this respect a sharp differentiation between the physical properties of molecules and atoms.

The lethal dose of criticism which killed the radiation hypothesis was based on the experimental proof that molecules are not able to do this very same thing, namely, absorb their critical quanta of activation $h\nu_1$ at the calculated frequency ν_1. The radiation hypothesis was killed because the assumption of the second part was made in ignorance of what molecules can do and cannot do.

It may be argued that the activated molecular states which are responsible for phosphorescence must be essentially different from those which function in chemical reaction, because their life periods are enormous compared with those of chemical processes. The fact remains, however, that in a series of different energy levels the uplift from a lower to a higher level cannot be achieved by the absorption of radiant energy of the frequency corresponding to the energy difference.

It may be pointed out that there is a close similarity between the effective methods of activation in the fields of photoluminescence and photochemistry. In each the activation is achieved by exposing the inactive molecules to radiant energy of a frequency equal to that of a characteristic absorption band of the inactive state, and this frequency is invariably greater than that calculated from the quantum of activation. Stokes's law, therefore, may be said to apply to photochemistry as well as to photoluminescence.

In view of the mechanism of activation which is common to photoluminescence and photochemistry, it is legitimate to inquire into the destination of the excess of the energy absorbed over the critical quantum of activation. The energy quantum absorbed by a single molecule may be denoted by $h\nu_0$, and the critical quantum of activation by $h\nu_1$, where ν_0 is greater than ν_1, and the question is what happens to the energy difference expressed by $h\nu_0 - h\nu_1$.

It is legitimate to assume that the energy difference is radiated as a single quantum $h\nu_2$. It may be suggested that this radiation during activation by light of frequency greater than that corresponding to the critical quantum of activation is the origin of fluorescence. Apart from any other argument, it is necessary that the radiation of some energy must accompany the activation of a molecule by light if Stokes's law is generally valid, and the view now brought forward is that under certain conditions this energy can be radiated as a single quantum of fluorescence. Fluorescence, therefore, should always be exhibited during the photo-activation of a phosphore.

The one essential criterion for fluorescence is the existence with a finite stability of an energy level intermediate between the initial level and the super-activated level to which the molecule is raised by absorbing the quantum $h\nu_0$. It is by no means necessary that the stability of the intermediate level be sufficiently great for delayed or phosphorescent emission to be visible when the molecule changes from this level to its normal level. The conditions for phosphorescence are far more restricted and rigid, one of these being that the phosphore must be in the solid state. It is therefore not surprising that fluorescence is of far more frequent occurrence than phosphorescence.

The principle of fluorescence radiation must also apply to photochemical reactions, in all of which the activating quantum is greater than the actual energy of activation. Here again the relation should hold that

$$h\nu_0 = h\nu_1 + h\nu_2,$$

where $h\nu_0$ is the quantum of energy absorbed at the characteristic molecular frequency in the ultra-violet, $h\nu_1$ is the critical increment and ν_2 is the frequency of the fluorescence. It would seem, therefore, that the suggested explanation of fluorescence may be put to a very severe test by the quantitative study of photochemical reactions. Some preliminary observations have been carried out at Liverpool by Mr. Leathwood and these give definite support.

It may be concluded that a definite position has been reached which is of some interest. The radiation hypothesis states that the first stage of a chemical reaction is the activation of each molecule of the reactant by the absorption of one quantum of energy, which has been called the critical quantum of activation. Evidence gained from the experimental investigation of the phenomena of photoluminescence gives strong support to the reality of this critical quantum of activation, but entirely disposes of the possibility of a molecule gaining this quantum by a single absorption process. The photochemical activation of molecules has been discussed in the light of the evidence gained from the fields of photoluminescence and absorption spectra, and the destination of the whole of the energy gained by a molecule when it absorbs its

photochemical quantum has been traced. Lastly, the connexion between the observed heat of a reaction and the critical increments of activation, derived by the radiation hypothesis, has been extended to the photochemical quanta, which is an advantage, since the photochemical frequencies can be directly observed by spectroscopic methods. It may even be considered that the exhumation of the radiation hypothesis has been partly justified.

There is no doubt, however, that this partial justification raises the question of thermal reactions in a form which is even more acute than was the case at the inception of the radiation hypothesis. The inability of a molecule to gain its critical quantum of activation by means of a single absorption process has been demonstrated in a far wider field than was covered by the experiments of Lindemann and G. N. Lewis, which as a matter of fact were devised *ad hoc*. Unless some mechanism exists whereby a molecule can gain its critical quantum of activation from a source of infra-red radiation, photochemical activation must be viewed as an abnormal event and the exhumed radiation hypothesis must be re-interred at once and for all time.

I have been led to re-open this question by some recent observations which appear to throw new light on the problem. These observations encourage me to suggest a possible mechanism of activation by infra-red radiation. Some justification may be found in the fact that it offers an explanation of many of the difficulties that have been met with in interpreting the phenomena observed in absorption spectra.

Mr. Hood at Liverpool has succeeded in determining the temperature coefficient of the reaction whereby carbohydrates are photosynthesised from carbonic acid in the presence of pure nickel carbonate; the relation between the temperature and the yield is linear between 5° and 31°. This result is of some interest in view of the fact that pure photochemical reactions have a temperature coefficient of unity. It has previously been shown that: (*a*) Carbonic acid in aqueous solution is not acted on by white light; (*b*) carbonic acid when adsorbed on a coloured surface does not react in the dark; (*c*) carbonic acid when adsorbed on a coloured surface and irradiated by white light reacts to give carbohydrates.

It follows as a necessary conclusion from the facts that the complete activation of the carbonic acid must take place in two stages, namely, partial activation by adsorption with the formation of a molecular state capable of absorbing some rays within the visible spectrum, whereby the activation is completed by photochemical means. Furthermore, the number of partially activated molecules which are able to enter into the final reaction is in linear proportion to the temperature. It is this first stage of partial activation which is of interest in our quest, since it is evident that the adsorption process alone is not sufficient to bring the molecules into a state which enables them to react photochemically under the influence of visible light, the supply of heat energy being necessary to add the finishing touch to the partial activation.

There is a striking analogy here with anisole and the other phenolic ethers and their nitro-derivatives in solution in concentrated sulphuric acid. There can be no doubt that the ether molecules in the acid solution have gained their critical quanta of activation, and yet their activated states must be stabilised in some way, since no measurable sulphonation takes place at ordinary temperatures. When the solution is warmed at 50° the expected reaction proceeds.

Now it is very probable that there is one factor which is common to the two sets of observations, namely, the existence of a complex, that is to say, an adsorption complex of carbonic acid and nickel carbonate in the one and an addition complex or solvate of the ether and sulphuric acid in the other. If the mechanism of complex formation be considered, it would appear that two methods are possible whereby a complex can be stabilised. The most usual case is when two components form a complex with a loss of energy, and such a complex will only be resolved into its components by the supply of energy equal to that lost in its formation. As an example of this type of complex the salt of an organic base such as aniline may be instanced, this type having a positive heat of formation.

On the other hand, it may be suggested that another possibility exists, namely, the formation of an addition complex of two components, one of which yields a definite amount of energy to the other. Such an energy transference, so far as external evidence is concerned, will be an isothermal process. It may further be suggested that the amount of energy given up by the first component to the second component is equal to the critical quantum of activation of the second component. Such complexes will not be formed between any two molecules, but only between two which satisfy the conditions, the criterion being that a molecule of one compound, possibly by loss of rotational energy, can give to the molecule of another compound energy equal to the critical quantum of activation of that molecule. A complex of this type may be denoted by the symbol $A^{-}B^{+}$, where B has gained its critical quantum of activation at the expense of the rotational energy of A.

Let it be accepted that such complex formation is possible in order that the properties of these entities and their probable influence on the phenomena under discussion may be critically examined. It may first be concluded that, even though the molecule B has become activated, the reaction characteristic of the activated state will not take place until the energy defect of the molecule A has been restored. In other words, the activated state of the molecule B has become stabilised. In the second place, the resolution of the complex into a normal molecule of A and an activated molecule of B will be secured by making good the defect in the rotational energy of the molecule A. The formation of a free molecule of B in the activated state is no longer a process of direct activation by radiant energy, which has proved to be impossible, but an increase in the rotational energy which, as is known, can be effected by means of infra-red radiation.

It must be emphasised that the temperature is a most important factor, and there must be for every complex a characteristic temperature limit, below which it is completely stable. When the temperature is progressively raised above the characteristic limit, an increasing number of complexes will be resolved in unit time, and the reaction velocity will increase. It may be said, therefore, that the stability of the complexes progressively decreases as the temperature is raised above the temperature limit, and it follows that there must be an upper temperature limit above which the complex will have no measurable stability, and at this temperature the reaction velocity of a simple chemical reaction will reach a maximum and will indeed be instantaneous, if such a word can be applied to a process involving the mixing together of the reactants. The photosynthesis reaction is differentiated by the fact that it consists of two stages, and the temperature limits concern only the stability of the adsorption complex characteristic of the first stage.

The hypothesis of complex formation also offers an explanation of the phenomena of photoluminescence. There is one outstanding fact in connexion with the activation of the phosphorogen in a phosphore which indicates the presence of a complex of the type we are dealing with. In all cases where the activating wave-lengths have been measured, these are longer than those which are characteristic of the phosphorogen in the free state. This at once leads to the view that each phosphorogen molecule has formed a complex with a molecule of the diluent, and within that complex the phosphorogen exists at a level of higher energy content than the normal. The stability of the complex will be determined by the temperature as it can only be resolved into its components by the supply of infra-red radiation to make good the defect in the rotational energy of the diluent molecule. Even though the phosphorogen component is raised to a still higher level by absorption of its characteristic quantum at the ultra-violet frequency, the complex will remain in its stable state provided that the temperature is below the lower limit characteristic of the complex.

An instance of an exactly analogous phenomenon is the very striking fluorescence of benzaldehyde in concentrated sulphuric acid solution. In this case the aldehyde within the complex absorbs and radiates energy without its stability being affected. It may therefore be suggested that even after the phosphorogen has been raised to a higher level of activation than that which it reaches in the actual formation of the complex, the new state is no less stable than the complex itself. If that be so, the whole of the phenomena of photoluminescence which have been previously described will find a simple explanation. There will be a lower temperature limit below which the activated complex will be completely stable, that is to say, no phosphorescence will be observed. When the temperature is raised above the lower limit the region of partial stability will be entered and phosphorescent emission will begin, and progressive rise of temperature will progressively increase the number of complexes that are resolved and the intensity of the phosphorescence will increase. Since there are present a finite number of complexes, the total persistence of the emission will decrease. At any constant temperature between the lower and upper limits the intensity will have a definite rate of decay. Just below the upper temperature limit where the stability is vanishingly small the persistence will be vanishingly small and the intensity will be the maximum. Up to this stage the phenomena will be identical with those of a chemical reaction, the criterion of intensity of phosphorescence being substituted for the criterion of reaction velocity. When the upper temperature limit is passed the complex will no longer have any stability and will no longer exist. No phosphorescence or fluorescence will be possible, since these depend on the stable existence of the complex with its power of retaining the energy which it absorbs at its characteristic frequency in the ultra-violet. These phenomena are identical with those observed by Lenard and Klatt.

One further piece of evidence, which has hitherto not been mentioned, may now be brought forward. The hypothesis of complex formation demands that the defect in the rotational energy of the 'catalyst' or diluent component may be absorbed as infra-red radiation. In all that has gone before this defect has been supplied by raising the temperature, and the hypothesis cannot be considered as entirely justified unless it be proved that resolution of the complexes can be achieved by exposure to infra-red radiation. The fact that the most effective method of deactivating an activated phosphore and of releasing the whole of its phosphorescence is by exposing it to infra-red radiation adds a conclusive argument in support of the hypothesis.

The success that has attended the application of the hypothesis of complex formation to widely differing phenomena justifies its general application to all thermal chemical reactions. This naturally leads to the view that every such reaction depends on the presence of a catalyst. There seems little objection to this because it is a fact familiar to everyone that chemical reactivity suffers a most remarkable decrease as all impurities are removed. It is perhaps a sweeping statement to make that no thermal reaction can take place in the complete absence of a catalyst, but the fact remains that in every case which has been accurately examined the reaction velocity is zero. In inorganic chemistry the most effective catalyst is water, and H. B. Baker's work on the absence of reaction between dry substances is classical. It may be that this power of water is connected with its great ionising power towards inorganic salts, for it is possible that ionisation itself is the result of a complex between solvent and solute.

It may be claimed that the evidence brought forward from the three fields of photoluminescence, absorption spectra, and chemical reaction constitute a story that is not without interest. The one dominating influence in this story is the critical quantum of activation which has found its experimental verification.

Manuscript Herbals.[1]

THE herbals which have come down to us from pre-Renaissance days offer a vast field for inquiry, as yet imperfectly explored. Dr. Charles Singer's new memoir not only affords invaluable clues to the labyrinth of codices which confronts the perplexed student, but also illuminates the subject by treating it on broad lines and relating it to the main currents of thought. Dr. Singer believes that the herbal—or descriptive drug-list of vegetable remedies—had already assumed its definitive form in the fourth century before Christ, though no work so early in date is extant. We owe our first knowledge of Greek herbal literature to the "Historia Plantarum" of Theophrastus. The Ninth Book of this work, which may perhaps date from a period later than the death of the reputed author in 287 B.C., is believed to be a compilation from which we may gain an idea of the nature of the earliest herbals.

The most important work of the period before Christ is, however, that of Krateuas of Pontus, the medical attendant of Mithridates (120–63 B.C.); Krateuas was the first author to produce a herbal with figures, and he is thus the father of plant illustration. No actual copy of his work has survived, but Dr. Singer believes that we have the material for restoring a considerable part of it, which seems to have been used some centuries later in association with another materia medica—that of Dioskurides. The manuscript, which has so fortunately preserved for us this fragment of the herbal of Krateuas, is the most illustrious of all the early botanical codices. It was prepared in Constantinople about the year A.D. 512 for a noble lady, Juliana Anicia, the daughter of Flavius Anicius Olybrius, Emperor of the West. For the next thousand years or so it remained at Constantinople, where it suffered various vicissitudes; in 1569 the diplomatist Augier Busbecq, when on a diplomatic mission to that city from the Emperor Ferdinand I., found it in the hands of a Jew, and induced his royal master to buy it for a hundred ducats. For a long period it was one of the chief treasures of the Hofbibliothek at Vienna, but as a result of the War it is now transferred to St. Mark's Library at Venice. The codex includes a picture of Krateuas engaged in painting a mandrake, which is conveniently held up for his inspection by Epinoia, the Goddess of Intelligence, while Dioskurides sits by, writing an account of the plant.

The text of the manuscript contains, among other matter additional to Dioskurides, an account of the uses of eleven plants, avowedly taken from Krateuas; these descriptions are accompanied by excellent illustrations, which may reasonably be regarded as ultimately derived from the same author's pictures, and thus as dating from about seventy-five years before the birth of Christ. Dr. Singer gives outline reproductions of these eleven pictures, from which we can gather an adequate impression of the essential character of the earliest of all illustrated herbals—the forerunner of the innumerable books with botanical pictures which have appeared in the two thousand years that have since elapsed. If we make allowance for the degradation which these drawings evidently suffered in the period of nearly six centuries which passed between their leaving the hand of Krateuas and appearing in the codex of Juliana Anicia, their qualities may well induce a sense of humiliation in the modern botanist; for their beauty and accuracy undermine the comfortable theory that the art of plant illustration has shown a progressive evolution. Indeed, it is not only on the artistic, but also on the medical side that degeneration rather than progress too often confronts the student of herbal literature as he passes the centuries in review.

Dr. Singer tells us that Andromachos of Crete, physician to Nero (A.D. 54–68), produced a modification of the *mithridate*, or panacea for all manner of poison, injury, and disease; and so late as the end of the eighteenth century, in certain continental cities it was still the custom to prepare once a year in public, in presence of the magistrates, a *Theriaca Andromachi*. The recipe of Andromachos himself included 45 items, while the eighteenth-century theriac had reached such absurd elaboration as to demand no less than 140 different ingredients! Though the theriac has died out under the wilting influence of modern scepticism, it has bequeathed to us the word 'treacle,' in which its memory survives as in an innocuous second childhood.

Andromachos was not the only Greek herbalist of the first century. Pamphilos, a physician who practised in Rome, had already written a book which appears to have been the first work on plants arranged in alphabetical order, and there were other writers of this period who dealt with vegetable drugs. All these herbalists are, however, entirely overshadowed in reputation by Pedanios Dioskurides of Anazarba, whose materia medica, which included about five hundred plants, was treated as the standard work for the next fifteen centuries—indeed in Arabic-speaking countries its influence survives even to the present day. Dioskurides, after studying in Alexandria and Tarsus, became physician to the Roman legions in Asia soon after the middle of the first century. His herbal shows an extensive knowledge of plants, but it does not reveal outstanding mental capacity or scientific insight. Attempts at the identification of the plants which he describes have occupied an astonishing amount of the time and energy of the botanists of later times; the difficulty of the task is due chiefly to the inadequacy of his descriptions, but in part also to the fact that even to-day the plants of Asia Minor have not been exhaustively explored. The authority attributed to Dioskurides led to the making of countless copies of his work, and the unravelling of the lineages of these various manuscript versions is a matter of the utmost difficulty and complexity. Dr. Singer gives a chart showing the results so far

[1] "The Herbal in Antiquity and its Transmission to Later Ages." By Charles Singer. (Reprinted from the *Journal of Hellenic Studies*, vol. 47, Part I., 1927.) Pp. 52+10 plates.

attained regarding the relationships and sources of the different groups.

We have already referred to the codex of Juliana Anicia. It is a signal instance of the passion for copying, rather than for original observation of Nature, which possessed herbalists even so late as the Renaissance period, that fifteenth-century copies of the illustrations of this manuscript are known—that is to say, a botanical artist in the fourteen-hundreds was content to copy figures, some of which may have originated in the period before Christ, rather than to draw the flowers which were ready to his hand in his own countryside and garden. The same almost incredibly slavish and brainless copying characterised the text. The plant synonyms, which are a feature of the manuscripts of Dioskurides, were copied and re-copied right into the sixteenth century, though many of them were in strange tongues, which had been extinct for more than a thousand years. Dr. Singer lays stress upon the fact that the creative period of Greek science came to an end in the second century of the Christian era, and that, during the Dark and Middle Ages, the illustrated manuscript herbals are merely literary products, the preparation of which involved no genuine knowledge of plants.

The materia medica of Dioskurides was not the only work of its class which was widely circulated in the Middle Ages. An immensely popular herbal was that of Apuleius, which is supposed to date from a Greek original of the fourth century; it is frequently combined with a Latin version of Dioskurides. How the name of Apuleius became associated with it is not known; the author of "The Golden Ass" had no concern with it. As in the case of Dioskurides, Dr. Singer gives a diagram indicating the probable descent of the principal groups of manuscripts. This herbal is of special interest to us in Great Britain, since versions of it exist which are of Anglo-Saxon and Anglo-Norman workmanship.

In the fifteenth century the inventions of printing and of wood-engraving rendered possible a new era in herbal history, but at first there was a failure to realise the distinctive potentialities of these inventions, and the earliest printed herbals diverged little from the preceding manuscripts. Dr. Singer concludes his work by demonstrating the continuity of the printed herbal with the manuscript tradition which gave it birth. His lucid memoir, with its numerous and exquisite illustrations, should awaken further interest in a subject which is far from being exhausted, and still stands greatly in need of workers trained in the methods of critical scholarship.

Obituary.

PROF. D. NOËL PATON, F.R.S.

THE death of Prof. Diarmid Noël Paton on Sept. 30 has removed an outstanding teacher of physiology, and a devoted investigator of the subject.

Noël Paton, the eldest son of Sir J. Noël Paton, the famous artist, was born in 1859. He was educated at Edinburgh Academy, where he had as classmates Herdman of Liverpool, D'Arcy Thompson of St. Andrews, and Haldane of Oxford. It is no wonder that when he passed to the University of Edinburgh he joined the Faculty of Science. He inclined at first towards zoology, then to botany, but having begun the study of medicine he found his real interest. After a distinguished undergraduate career he proceeded to Vienna for a short period of post-graduate medical work, and on his return to Edinburgh commenced general practice. He was offered and accepted a biological fellowship in the University of Edinburgh, and two years later, in 1886, he was appointed lecturer in physiology at Surgeons' Hall. He was able to devote his whole time to research and teaching when, in 1889, he was appointed superintendent of the Research Laboratory of the Royal College of Physicians, Edinburgh. He continued hard at work in Edinburgh until 1906, when he was nominated by the King to the Regius professorship of physiology in the University of Glasgow.

Noël Paton may rightly be regarded as one of the last 'all round' physiological teachers in Britain. He had a very wide and deep knowledge of his subject. Much of his energy and enthusiasm was given to the conduct of his classes. He was a born teacher, and he expressed his views with clarity and thoroughness, being scrupulous to put before the student all sides of the problem under discussion. He believed intensely in his own interpretation of the facts, but he was insistent that the student should also make up his own mind. Even the appearance of laying down the one and only law was anathema to him. Throughout his course of physiology he never forgot that the majority of his hearers were going to be practitioners of medicine. He related as much as possible of his teaching to clinical work, often illustrating his points by the display of actual patients.

As a research worker Noël Paton was keen and energetic. He attacked his problem with a passionate devotion to the task, and he was unswerving in his endeavour to reach the truth. He had a horror of cheap and shoddy work. Any kind of special pleading, of the suppression of material facts or negative results, roused him to a righteous fury. His early research work was mainly devoted to chemical physiology; he was, indeed, one of the first workers in Britain to investigate metabolic problems. Although until the end he was interested in the chemical aspects of physiology, yet, as his own published work and that of those who worked under his direction show, his interests were wide and varied. This width of outlook is conspicuous in two of his books, "The Regulators of Metabolism" and "The Continuity of Life." It did not matter to him if his ideas clashed with popular or commonly accepted opinion.

So far as individual pieces of laboratory research are concerned, probably the most valuable is his

study of the parathyroids. Whether or no his conclusions stand the test of time, this work will always hold its place as one of the most complete and far-reaching studies of the subject. Nutrition always held a first place in his affections, and he was responsible for some of the most interesting dietary studies carried out in Britain. These studies culminated in the comprehensive study of child life done in conjunction with Prof. L. Findlay, and published as a Medical Research Council report under the title of "Poverty, Nutrition, and Growth."

Beneath a rather formal, sometimes aloof, but always graceful appearance, Noël Paton hid a very warm, sensitive, and kindly heart. It is perfectly true that he did not suffer fools gladly, but no case of real hardship left him unmoved. As a colleague he was always anxious and willing to allow full credit to his co-workers, and he contributed freely and generously of his experience. As Prof. Macneile Dixon said in his valedictory address at the graveside, "There were qualities in him, in that sensitive artist nature of his, shy and precious qualities, qualities he would fain have hidden, which did not make life easier for him, but which endeared him to his closer friends." These are true words. He lived for science. As he said himself on one occasion, the joy of sailing upon the ocean of discovery is to the man of science the real joy of life. But science was to him more than mere joy, it was a religion the teachings of which he accepted unfalteringly. His belief in and respect for these teachings ruled his life. E. P. C.

Prof. S. Oppenheim.

Samuel Oppenheim, professor of astronomy in the University of Vienna, died in that city on Aug. 15, in his seventy-first year. He had graduated at Vienna in 1880 in the subjects of mathematics, physics, and astronomy, and obtained the doctor's degree in 1884 with a thesis on a new method of integrating the equations of planetary theory. He was an observer at the University Observatory, Vienna, until 1889, when he moved to the Vienna-Ottakring Observatory, remaining there until 1896; he also took pupils in astronomy during this period. In 1896 he moved to Arnau, where he taught astronomy in a school; he went to Prague in a similar capacity in 1899, remaining there until 1911, when he was appointed professor at Vienna.

Oppenheim's interests were mainly in gravitational astronomy; he worked on the perturbations of asteroids, the problem of three bodies, and the distribution and motion of the stars. He wrote several encyclopædia articles on astronomical and gravitational subjects, and gained a high reputation as a teacher. His health began to fail last winter; he succeeded, though with difficulty, in attending the meeting of the Astronomische Gesellschaft at Heidelberg in July, but he died only four weeks after his return home.

For many of the above details we are indebted to an article by J. Rheden, of the University Observatory, Vienna, in *Astr. Nach.*, No. 5585.

Miss Jessie L. Weston.

The death is announced of Miss Jessie Laidlay Weston, D.Litt., which took place in London on Sept. 29 at the age of seventy-seven. Miss Weston was born on Dec. 29, 1850, and educated at Brighton, Paris, and Hildesheim, and studied art at the Crystal Palace School. In 1890, at the suggestion of the late Alfred Nutt, and with the view of making the stories of the Wagner dramas more widely known in England, she took up the study of the Arthurian Legend. Her first work was a translation of "Parzival," by Wolfram von Eschenbach, and this was followed by a series of studies of the origins and development of the Arthurian Cycle. She dealt in succession with Sir Gawain, Sir Lancelot du Lac, Sir Perceval, and "The Three Days' Tournament," her studies being published in the Grimm Library. Then followed "Seven Arthurian Romances Unrepresented in Malory," "Romance, Vision, and Satire," and "Chief Middle English Poets."

Miss Weston was a finished scholar and a sound and acute critic, with a breadth of interest that took her beyond the purely literary or textual aspects of her material. As was shown in her last published book, "From Ritual to Romance," which appeared in 1920, origins meant more to her than purely literary sources, bereft of their context of belief and custom. At the time of her death Miss Weston was engaged on a study of the origin of the French romance "Perlesvaux." In addition she was a contributor to the "Encyclopædia Britannica" and the "Cambridge History of English Literature," as well as the *Folklore Journal*, *Revue Celtique*, and other and specialist periodicals. In recognition of her services to Celtic literature, in 1923 she was made a D.Litt. of the University of Wales.

We regret to announce the following deaths:

Prof. R. A. Berry, professor of agricultural chemistry at the West of Scotland Agricultural College, Glasgow, on Oct. 12, aged fifty-two years.

Brigadier-General W. H. Bixby, formerly of the U.S. Army, a former president of the Mississippi River Commission, of the International Navigation Congress (1912), and of the Society for Testing Materials (1917), distinguished for his work on bridges, rivers, and harbours, on Sept. 29, aged seventy-eight years.

Prof. G. H. Bryan, F.R.S., formerly professor of pure and applied mathematics at University College, Bangor, and author of "Stability in Aviation," on Oct. 13, aged sixty-four years.

Prof. J. E. Kirkwood, head of the department of botany at the University of Montana, who worked on the botany of the Rocky Mountains region, on Aug. 16, aged fifty-six years.

Dr. David Murray, a distinguished student of the history and archæology of Glasgow, vice-president of the Society of Antiquaries of Scotland in 1900–3, and president in 1904–7 of the Royal Philosophical Society of Glasgow, on Oct. 2, aged eighty-six years.

Prof. A. H. Patterson, professor of physics and dean of the school of applied sciences in the University of North Carolina, known for work on high tension phenomena, aged fifty-eight years.

News and Views.

IT is not an infrequent practice nowadays to supply details respecting the centenaries and bicentenaries of famous men oftentimes considerably in advance of the precise dates when these events fall. This has happened with regard to Capt. James Cook, the two-hundredth anniversary of whose birth at Marton, Yorkshire, is on Oct. 27. A brief account of Capt. Cook's life and explorations appeared in our issue of Sept. 29, p. 484; the following references to his association with the Royal Society will be a fitting and timely supplement to that article. Of Cook's first voyage in the *Endeavour* (1768–71), Capt. Wharton, F.R.S.—remembered by those of an older generation as Hydrographer to the Admiralty—said that "it was to the English nation the most memorable voyage of discovery that has ever taken place"; and, on thinking over these significant words, we cannot in justice fail to link Cook's continuity of effort and outlook with the fortunate association during the voyage of Joseph Banks, F.R.S., and Dr. Solander.

AT the time of this voyage Capt. Cook was forty years of age; Banks was twenty-five (he had been elected into the fellowship of the Royal Society at twenty-three), was wealthy, willing to spend to the uttermost on equipment, and enthusiastic for the acquisition of knowledge relating to races of men and Nature's products. Solander had been the specially favoured pupil of Linnæus, the "much loved pupil." One can imagine the joy and satisfaction which held the leader upon the confirmation of their companionship. Sir Joseph Hooker, commenting thereon, has written: "It needs no reading between the lines of the great navigator's journal to discover his estimation of the ability of his companion (Banks), of the value of his researches, and of the importance of his active co-operation." Here it may be mentioned that Priestley was invited by Banks to join the expedition, but official objections prevailed against his wish. On the outward sailing the *Endeavour*, calling at Rio de Janeiro, met with a cold reception. A letter from Cook to Dr. Morton, Sec. R.S. (the original of which is in the possession of the Royal Society) records: "No one Gentleman in this Ship have been permitted to go ashore at this place, this unheard of Treatment has not only prevented Mr. Green and myself from making any Astronomical observations here, but Mr. Banks and Doctor Solander from Collecting any of the productions of this country." However, in spite of this trouble, Banks succeeded in landing, and in collecting no fewer than 316 plant specimens, a tribute to his tenacity of purpose.

SIR ARCHIBALD GEIKIE, in his book on the Royal Society Club, notes that Capt. Cook, fresh from his great voyage, universally hailed, dined with the Club on Nov. 21, 1771, on the invitation of Dr. Maskelyne, and in the following week as the guest of Banks. Again, that the navigator dined with the Club eight times in the first half of the year 1776. The news of the massacre of Cook reached England in 1779. With the object of perpetuating his services and memory the Royal Society instituted a medal, which was struck in gold, silver, and bronze. The principal artists of the day had submitted designs, and one by Lewis Pingo, chief engraver to the Royal Mint, was adopted. The obverse bears the bust of Cook in naval dress; the reverse a representation of Britannia pointing to the south pole of a globe. The legend reads: "Our people have left nothing unattempted." King George III., the King of France, and the Empress of Russia received gold impressions. A gold example (now in the British Museum) was given to Cook's widow, and one to Benjamin Franklin. Banks, writing to the latter, refers to "those liberal sentiments which inclined you, upon Cook's return to Europe unexpected, to issue your orders to such American cruisers as were there under your direction, to abstain from molesting that great navigator." There is a portrait of Cook in the National Portrait Gallery by John Webber, R.A., a painting dated 1766, artist unknown, and a marble bust, attributed to one Le Vieux; a bronze statue of Cook stands in the Mall near the Admiralty Arch.

ON Oct. 31 occurs the centenary of the birth of Sir Joseph Wilson Swan, who was born in Sunderland in 1828 and died at Warlingham, Surrey, on May 27, 1914. Apprenticed to a firm of chemists at Sunderland, he afterwards became a successful chemical manufacturer and an eminent original investigator, and was widely known for his introduction of the carbon process in photography, his invention of bromide printing paper, and the introduction of the Swan incandescent electric lamp. So early as 1860 he produced slender carbon filaments of sufficient strength, elasticity, and conducting power to serve as light-giving material *in vacuo* for incandescent lamps, but he first exhibited such a lamp at a lecture in Newcastle in 1879. The following year, on Nov. 20, 1880, he lit the rooms of the Literary and Philosophical Society of Newcastle by means of such lights, and this was the first public lighting of a hall with his lamps. Swan was elected a fellow of the Royal Society in 1894, served as president of the Institution of Electrical Engineers, the Society of Chemical Industry, and of the Faraday Society, and received the Hughes and Albert medals for his work on the incandescent lamp.

NEWS has been received that the members of the British Association Expedition to the Great Barrier Reef have established their camp on the Low Islands near Cairns. Their personnel has been increased by five Australian naturalists, and Mrs. Stephenson has been appointed a member of the expedition, so that the party numbers seventeen. They are housed in three laboratory and living huts with outbuildings, while the lighthouse keepers have given hospitality to instruments of precision. For labour they have aboriginal or half-caste boys, who seem to be satisfactory. The equipment arrived in good condition, and the Australian Navy, the Amalgamated Wireless, and the Bureau of Meteorology have completed this by the

loan of instruments. A tide gauge has been erected and rafts put out for collecting and observing animals. Mr. Wishart has placed himself and his boat, a 38-feet ketch with 15 h.p. Kelvin engine, at their disposal on reasonable terms, and regular plankton and hydrographic stations are being taken, though the South-East Trades make work difficult. A smaller boat has been bought for lagoon and shore work. For deep sea work, if funds can be obtained, it is proposed to hire a larger vessel which plies in neighbouring waters. Profs. Richards and Goddard are expected to visit the party in November.

LOW ISLANDS seem to have been well chosen. They are half-way, seven miles, between the inner barrier and Port Douglas. There is good anchorage on the north of the island. There are two islands, that on which the camp is situated being of sand and 250 yards in diameter; the other is a very dense mangrove swamp. They are connected with a great area of flat reef, and are about ¾ mile apart. The reef is edged with a low boulder zone, inside which are a series of shallow lagoons rich in life. At spring tides the surrounding coral growth is of great richness and variety. Messrs. Russell, Orr, and Marshall are working the boat stations, while Dr. Stephenson has marked off areas of reef for intensive study. Mr. Moorhouse, of the University of Brisbane, has started a Trochus farm. Mr. Tandy is collecting and observing the Algæ. Dr. Yonge, with Mr. Nicholls of the University of Western Australia, is studying corals from the point of view of symbiotic Algæ and feeding. Mr. Otter is working on the bionomics of boring organisms and the effect of such on the breaking up of reefs. All are in good health, and the whole work seems to be going smoothly. The party is enthusiastic in respect to its reception in Australia.

SIR ARTHUR KEITH, in a presidential address on the racial frontiers of Britain, delivered to a scientific society at University College, Aberystwyth, on Oct. 16, traversed the orthodox view of historians which explains our racial frontiers by a theory of successive racial waves from east to west. This theory is based upon the conception that racial migration into Great Britain was by way of the east coast from the Continent. Sir Arthur, however, expressed his adherence to the view which has been gaining ground steadily during the present century, that we have also to look to the west, where there is evidence for an infiltration of peoples who reached Britain from the sea for at least 2000 years before Christ. As is shown by the distribution of megalithic monuments, Mediterranean peoples in succession reached Spain, crossed France to Brittany, and then passed onwards to the south and west of England, to Wales, the coastal lands of Ireland, the Atlantic seaward of Scotland as far as the Orkneys. On the other hand, the eastern side was invaded by the Beaker folk, and this North Sea invasion was mainly confined to lands which afterwards became settled by Saxons. The penetration of the Celtic-speaking peoples to the Mediterranean people of the west, he inferred, was largely peaceful, and imposed its language upon them. When, later, Britain was colonised by the Saxons, Wales alone was the only part of the ancient racial divide of Britain which persisted as a sharply marked line.

THE inaugural address for the 1928–29 session of the Biochemical Society, University of Birmingham, was delivered on Oct. 18 by Prof. S. B. Schryver, of the Imperial College of Science and Technology, London, who discussed some aspects of the chemistry of the proteins. He dealt mainly with the method of separating the products of hydrolysis of the proteins, showing that the 'esterification' method introduced by Emil Fischer is inadequate. He then described the 'carbamate' method, which consists in converting the amino-acids into the barium salts of their carbimates. During the course of this work three hitherto unknown products of hydrolysis have been discovered, namely, hydroxylysine, hydroxyamino-butyric acid, and hydroxyvaline. Attention was directed to the fact that for nearly every amino-acid found amongst the hydrolysis products, the corresponding hydroxy-acid has also been found. There is, however, one important exception, namely, leucine; in an attempt to isolate hydroxyleucine, a new base with eight carbon atoms has been discovered, to which the name protoctine has been given. Another method more convenient than the 'carbamate' method for separation of the products of hydrolysis has given still more satisfactory results, leading to the isolation of one more hitherto unknown product, the nature of which has not yet been finally determined. The essential feature of this second method is the separation of the copper salts into three fractions. In conclusion, Prof. Schryver suggested that the peptide structure of the proteins, suggested by Fischer, only accounts for the mere skeleton of the protein molecule. The proteins contain active peripheral groups, and readily undergo intramolecular changes. The presence and action of these peripheral groups may possibly account for the intense physiological activity displayed by the proteins.

THE Annual Report of the Meteorological Office for the year ending Mar. 31, 1928, directs attention to the expanding work of this department. Meteorological data for the British Isles are now obtained from 343 stations, of which 23 are maintained by the staff of the office, 28 are chiefly coastguard and lighthouse stations, 23 are known as 'crop-weather stations,' and are in certain agricultural colleges and research institutions, and 267 are private stations taking observations only once a day. In addition, there are nearly five thousand stations supplying records of rainfall only. The report notifies certain changes in the publications of the office. The *Weekly Weather Report* has ceased and is to be replaced by an annual volume which will contain data by calendar weeks both for stations and districts as heretofore, but the number of stations will be reduced to five for each district. In the *Monthly Weather Report* the records of a number of stations, where many occur close together, have been omitted as unnecessary in representing the meteorological conditions of the country. In "British Rainfall," the practice of giving the falls in millimetres as well

as inches has been discontinued, and the space saved in the tables has been used for the figure of the average annual rainfall in inches. In the forecasting department arrangements have been made to warn the public and a number of authorities when weather conditions appear likely to cause high tides in the Thames. This will give ample warning of floods.

IN "Disembodied Spirits" (Ipswich: The Ancient House Press. 6*d*.) Mr. Reid Moir has contributed a vigorous attack upon the methods of modern investigators of spiritualism. Briefly tracing the history of man's belief in ghosts, he points out that the common appeal to the verdict of certain well-known men is merely slavish homage to authority, since science has no more relationship to spiritualism as now conducted than engineering has to poultry breeding. Indeed, he adds, it is difficult to imagine any subject more clearly divorced from scientific method and research. Continuing, Mr. Reid Moir suggests that the hypothesis of spirit interference is the least probable of all the hypotheses, and that when competent and critical investigation is permitted, it may be found that the modern belief in ghosts is as baseless as many other of the happily forgotten fancies associated with the early development of mankind.

THE United States Department of Agriculture has pressed the aeroplane into service in the exploration it continually carries on for new varieties of plants that may be of value if brought under cultivation. Dr. D. W. Brandes has recently returned from the interior of New Guinea, where he has been using this method to hunt for new varieties of sugar cane. 171 distinct varieties of cane were secured, one of them a species described as new to science. Collected by this rapid method of transport, the canes are being brought back alive, and will be put under cultivation in suitable regions in the United States. They can then be used for purposes of hybridisation and examined as to their possibilities of disease resistance.

THE flourishing condition of the Botanical Society and Exchange Club of the British Isles is indicated by the Report for 1927, edited by the secretary, Dr G. C. Druce. In addition to notes and records of interest to British botanists, a number of papers are contributed by various authors. Those of most general importance deal with the flora of St. Kilda, the adventive flora of the Metropolitan area, British plants contained in the Du Bois Herbarium at Oxford, 1690–1723, some English *Alchemillas*, phenological observations made at Oxford, and a visit to the Canaries. Under the heading of "Personalia and Various Notes" we are pleased to note a commendation of the scheme for a series of transplant experiments undertaken by the British Ecological Society at the suggestion of the Director of the Royal Botanic Gardens, Kew. As the editor of the report states, "it is mainly by comparative cultures of authentically named plants that their true grades can be ascertained."

THE Russian Academy of Sciences Commission for the Study of Nationalities of Russia has begun the publication of a new quarterly, under the title *Chelovek* (Man). The first part for 1928 contains an editorial defining the aims of the journal, as a medium for publishing original works and reviews of literature on all problems connected with the study of man from the bio-anthropological point of view. Amongst the contents of the first part may be noticed an interesting paper by J. A. Philiptchenko on recent investigations of the problem of inheritance of genius, partly based on the author's own research amongst families of some famous Russian men of science. N. A. Podkopaev gives a very concise account of the problem of conditioned reflexes, as studied by Pavlov and his school. A review of results achieved in the study of palæolithic man in Russia is presented by P. P. Efimenko, while L. S. Berg contributes a most useful list of the ethnographical maps published in Russia since the seventeenth century. A very important section of the new publication is that containing records of current events in the study of ethnography and anthropology; in this section many useful and interesting data on the organisation and work of various Russian institutions and expeditions are included.

BEGINNING in July last, the Bureau of Standards at Washington is sponsoring a new monthly *Journal of Research* which will replace the well-known series of *Scientific Papers* and *Technologic Papers* which up to now have been published under the auspices of the Bureau. The new journal will in future be the official medium for the publication of original papers from the Bureau of Standards, whether on pure or applied science, together with critical reviews on science and technology. The size of page is approximately that of the *Philosophical Magazine*. There are to be two volumes a year, obtainable at an annual subscription of 2·75 dollars in N. America and 3·50 dollars elsewhere, from the Superintendent of Documents, Government Printing Office, Washington, D.C., U.S.A. It may be noted that reprints of individual papers will also be purchasable. The July issue of the *Journal of Research* contains 104 pages and several plates devoted to five different papers covering subjects as wide apart as reflectometry, interferometry, tread-movement and wear in pneumatic tyres, accelerated tests of paints, varnishes, etc., and the chemical analysis of refractories. There is, we think, no question that the new form of publication adopted by the Bureau will be found more generally convenient than the method formerly adopted.

FROM *The Librarian and Book World* (Gravesend) we have received the new edition of "The Libraries, Museums, and Art Galleries Yearbook," corrected to the end of 1927. A useful feature in this is the index to collections of books dealing with special subjects, such as agriculture, anthropology, antiquities, archæology, down to weapons (savage), wool, and zoology. The alphabetical list of librarians and curators should also be of service. The information as to libraries under the head of each town is condensed and practical. For the first time a selection of libraries of the British Empire and foreign countries

is included. The scheme of the book is good, but mistakes and omissions are more than need be. Such obvious sources of information as the Telephone Directory, *Whitaker's Almanack*, and the *Museums Journal* would have enabled the editor to put many right. In future, he will have Sir Henry Miers' Report on Museums to the Carnegie Trustees and the ASLIB Directory so far as Great Britain is concerned. Still, for those who need such a work of reference, the book is worth the 25 shillings asked.

THE issue of the *Journal of the Franklin Institute* for June contains a 60-page report of the work being done at present under the Bartol Research Foundation. It is a reproduction of the address of the Director of the Foundation, Dr. W. F. G. Swann, to the Franklin Institute on Mar. 15 last. In it the nine or ten investigations which are being carried out are described in such a way that the nature of the problem each is intended to solve, the method of attack, and the nature of the results obtained up to the present, are quite clear to a reader not necessarily a specialist in the subject concerned. Details of experiments are omitted as the concern of the specialist only, and the whole report forms interesting reading. The principal researches are on the cosmic radiation, X-rays, the reflection of hydrogen atoms from the surfaces of crystals, the nature of the electric arc between metallic electrodes, thermionics, the dielectric constants and electrical conductivities of salt solutions, the passage of light through sodium vapour, and the possibility of producing a magnetic field by rotating a conductor. This form of report, of interest to the general reader, seems to us well worthy of imitation.

GRAVITY observations from a submarine were taken some years ago by Dr. Vening Meinesz on a journey between Holland and Java on a Dutch vessel. Using the same apparatus, Dr. Meinesz was leaving New York in October on an American submarine for a cruise in the Caribbean Sea and Gulf of Mexico. A recent *Daily Science News Bulletin*, issued by Science Service, Washington, D.C., reports that he was to be accompanied by Dr. F. E. Wright, of the Carnegie Institution Geophysical Laboratory. The course of the submarine is to be made to cross the deepest waters in the West Indies in order that observations of the force of gravity may be made where the earth's crust is farthest removed from the sea-level. The cruise is expected to last for several months.

No. 1, Vol. 28 of *Natural History*, that most attractive popular journal of the American Museum of Natural History, is devoted entirely to fishes. The fourteen articles cover a wide range of interest, and, as is usual with this journal, they are accompanied by admirable illustrations, several of which are in colours. Anglers will find much to interest them in this number. Mr. Zane Grey describes the results of two remarkable fishing expeditions in New Zealand waters in 1926 and 1927. Among the record catches mentioned are: a black marlin (*Makaira marlina*) of 976 lb.; a striped marlin (*Marlina mitsukurii*) of 450 lb.; a yellowtail (*Seriola dorsalis*) of 111 lb.; a thresher shark (*Alopias vulpes*) of 640 lb., the largest ever taken on rod and reel; and a broad-bill swordfish of 400 lb., the first *Ziphias gladius* ever caught with rod and reel in New Zealand waters. Another article deals with the Zane Grey Game Fish Collection in the Hall of Fishes in the American Museum, which includes many of Mr. Grey's most notable sporting catches. Van Campen Heilner describes his experiences in catching the bonefish (*Albula vulpes*), which he considers "the gamiest fish of any size or species in either fresh or salt water that an angler can hope to take." By way of contrast, there is an interesting description of the primitive lines, hooks, and sinkers used by native fishers for the oilfish (*Ruvettus pretiosus*) in deep water, where the bottom may be reached at say 400 fathoms. Those readers more interested in general natural history are also well catered for. Mention must also be made of a general article by Dr. W. K. Gregory, which takes the form of a tour of the new Hall of Fishes of the American Museum. Judging from the illustrations given in this article, the new exhibit should prove a highly attractive one.

AT the annual statutory meeting of the Royal Society of Edinburgh, held on Monday, Oct. 22, the following officers were elected:—*President:* Sir Alfred Ewing; *Vice-Presidents:* Dr. James Currie, Dr. A. Crichton Mitchell, Prof. W. C. McIntosh, Sir Robert W. Philip, Prof. J. Graham Kerr, and Prof. W. Wright Smith; *General Secretary:* Prof. R. A. Sampson; *Secretaries to Ordinary Meetings:* Prof. C. G. Darwin and Dr. James Ritchie; *Treasurer:* Dr. James Watt; *Curator of Library and Museum:* Prof. D'Arcy Thompson; *Council:* Prof. Richard Stanfield, Dr. A. Logan Turner, Dr. G. W. Tyrrell, Prof. J. H. Ashworth, The Hon. Lord Constable, Prof. E. Taylor Jones, Mr. J. B. Clark, Prof. F. A. E. Crew, Prof. J. Montagu F. Drummond, Mr. D. A. Stevenson, Prof. H. W. Turnbull, and Sir James Walker.

THE Council of the Institution of Civil Engineers has recently made the following awards for session 1927–28 in respect of selected engineering papers, published without discussion: A Telford Premium and an Indian Premium to Mr. F. C. Griffin (Calcutta); Telford Premiums to Messrs. R. A. Inglis (Buenos Aires), A. C. Vivian (Abadan, Persian Gulf), H. Herrod (Southsea), G. Parker (Cairo), and A. O. W. D. Pinson (Cairo); and in respect of papers read at students' meetings in London or by students before meetings or local associations during the same session: The James Forrest Medal and a Miller Prize to Mr. G. L. Goulden (Manchester); and Miller Prizes to Messrs. A. J. P. Pashlar (Birmingham), W. T. Shaddock (Barnstaple), E. C. Cookson (London), W. H. G. Mercer (Manchester), C. O. L. Gibbons (Stourbridge), E. M. Richardson (Manchester), J. S. Robertson (Glasgow), and S. N. Kelly (Glasgow).

RECENT appointments to scientific and technical departments made by the Secretary of State for the Colonies include one assistant conservator of forests, Mr. I. R. Dale to Kenya Colony, and two veterinary appointments, Major H. Greenfield to be veterinary

surgeon, Barbados, and Mr. R. S. Marshall to be assistant veterinary pathologist, Nigeria. There are four appointments to agricultural departments: Mr. R. M. Davies to be Superintendent, Agricultural Department, Nigeria, Mr. J. D. Broatch and Mr. C. L. Skidmore to be assistant superintendents of agriculture, Gold Coast, and Mr. J. E. Bruce to be a district agricultural officer, Tanganyika Territory. The three last named were holders of colonial agricultural scholarships. Mr. G. G. Auchinleck, who was appointed deputy director of agriculture, Gold Coast, from Ceylon in 1925, now succeeds Mr. C. H. Knowles, who retires from the post of Director of Agriculture, Gold Coast.

THE nineteenth Annual Exhibition of Electrical, Optical, and other Physical Apparatus is to be held by the Physical Society and the Optical Society on Jan. 8, 9, and 10, at the Imperial College of Science and Technology, South Kensington. As on previous occasions, the Exhibition will be divided into a Trade Section, comprising the exhibits of manufacturing firms, and a Research and Experimental Section. The Exhibition Committee invites offers from research laboratories and institutions, and from individual research workers, of exhibits suitable for inclusion in the Research and Experimental Section. The exhibits in this section will be arranged in three groups: (*a*) Exhibits illustrating the results of recent physical research; (*b*) lecture experiments in physics; (*c*) historical exhibits in physics. Offers of exhibits for these three groups should be communicated immediately, and in any case not later than Nov. 14, to the Secretary, Physical and Optical Societies, 1 Lowther Gardens, Exhibition Road, London, S.W.7.

A REVIEW of the work of the Rockefeller Foundation for 1927, by its president, Dr. George E. Vincent, has been issued. The total disbursements for the year amounted to 11,223,124 dollars. This includes a sum of two million dollars towards a site for the University of London. The remainder has been expended in promoting public health organisations and nursing training schools in many lands, in grants to departments of schools of public health and biology, in the provision of 864 fellowships for study and research in preventive medicine, in a grant towards the publication of *Biological Abstracts*, in a contribution to the Health Organisation of the League of Nations, and in many minor appropriations for promoting human welfare.

THE *Quarterly Review of Biology*, published by The Williams and Wilkins Company, Baltimore, U.S.A. (the English agents being Baillière, Tindall and Cox), is one of the liveliest of biological publications. Its book notices are characterised by their downright opinions as well as by their caustic humour, and the main articles are valuable contributions, particularly directed towards the elucidation of general biological problems. In the June number, Prof. John Tait writes on "Homology, Analogy, and Plasis," Remington Kellogg concludes his articles on the adaptation of whales to life in the water, R. M. Oslund discusses "Seasonal Modifications in Testes of Vertebrates," and Raymond Pearl's "Evolution and Mortality" has already been noticed amongst our Research Items. There are other equally important discussions, but the above gives a fair indication of the scope and interest of the number.

A LIST of life-saving stations of the world, now in its second and much revised edition, is published by the International Hydrographic Bureau as *Publication 18* (price 30 cents). It gives the name, latitude, and longitude and kind of apparatus kept at every station in the world. The text is in both English and French, and the Bureau gives full permission to anyone to reproduce the work in any other language. The most noticeable feature is the long list of countries on the coasts of which there are no live-saving stations. This is intelligible in certain lands which are off the track of shipping or in others which are still under the control of unprogressive governments, but it is surprising in the case of such countries as Newfoundland, Burma, and India (except Karachi), Jamaica, Cuba, Tasmania, and the whole of Africa except Algeria, Tunis, and the Union of South Africa.

A LIST of classified geological photographs, arranged under subjects, has been compiled from the set of photographs taken by officers of the Geological Survey during the last thirty years in the course of their work in Great Britain. The complete set, numbering above 7000, is preserved in albums deposited in the libraries of the Survey and Museum at 28 Jermyn Street, and at the Scottish Office, 19 Grange Terrace, Edinburgh. The present list, which occupies 80 pages, has been prepared to help teachers, and the public in general, to make a suitable and rapid selection of the more interesting and striking photographs. Prints and lantern slides are supplied to order at reasonable prices, and, as shown by actual experience, within a reasonable time. Copies of this most useful and trustworthy publication are obtainable at a shilling each from H.M. Stationery Office (Adastral House, Kingsway, W.C.2; York Street, Manchester; 120 George Street, Edinburgh; or 1 St. Andrew's Crescent, Cardiff).

WE have received the annual report for 1927–28 of the National Institute for the Blind (224 Great Portland Street, London, W.1). The work of the Institute is surveyed and the activities of the blind are depicted in a number of illustrations. A research committee is constantly engaged in perfecting existing, and seeking new, methods for minimising the hardships of blindness by mechanical means. The production of literature in Braille and Moon types forms are important branch of the work of the Institute, and during the year nearly 18,000 bound volumes in Braille were issued, including several works on scientific subjects. The Institute may be helped not only by monetary contributions but also by volunteer workers for the production of Braille books, etc.

THE University of Columbia has recently published the Chandler Lecture delivered by Prof. M. Gomberg on the occasion of the presentation to him of the

Chandler gold medal in December 1927. Prof. Gomberg is well known for his work on free radicals and tri-valent carbon, and his lecture took the form of a review entitled "Radicals in Chemistry, Past and Present."

MESSRS. Galloway and Porter, Ltd., Cambridge, have just issued a catalogue (No. 163) of upwards of a thousand works on mathematical and physical science offered for sale by them. The prices asked appear very reasonable. The catalogue contains as an addendum particulars of a number of pamphlets on the same subjects, many out of print and not easily obtainable.

IN the autumn announcement list of Messrs. Methuen and Co., Ltd., we notice the following forthcoming books of science: "The Great Chemists," Dr. E. J. Holmyard; "Mine Ventilation: The Generation of the Air Current," Prof. H. Briggs; "X-rays," Dr. B. L. Worsnop; "The Applications of Interferometry," W. E. Williams; "Wireless," J. A. Ratcliffe; "Mechanical Aptitude: Its Existence, Nature, and Measurement," Dr. J. W. Cox; "Psychology and Modern Materialism," Prof. W. McDougall; "Psychology as Science: Its Problems and Points of View," H. P. Weld; and "The Desert Road to Turkestan," O. Lattimore.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant master for chemistry and physics in the Wimbledon Junior Technical School for Boys—The Principal, Technical Institute, Gladstone Road, S.W.19 (Nov. 2). An Ackroyd memorial research fellow for textile industries in the University of Leeds—The Clerk to the Senate, University of Leeds (Nov. 3). A demonstrator in agricultural botany in the Department of Botany, the University, Leeds—The Registrar, The University, Leeds (Nov. 12). A professor of physiology at the King Edward Medical College, Lahore—The Inspector-General of Civil Hospitals, Punjab, Lahore (Dec. 1). A junior assistant under the Directorate of Ballistics Research, Research Department, Woolwich—The Chief Superintendent, Research Department, Woolwich, S.E.18. An assistant lecturer in physical chemistry in the University of Leeds—The Registrar, The University, Leeds.

Our Astronomical Column.

THE ROTATION PERIOD OF NEPTUNE.—J. H. Moore and D. H. Menzel have investigated this period by the spectroscopic method, using the 36-inch refractor at Lick (*Pubs. Astr. Soc. Pacific*, August). They placed the slit parallel to the planet's equator, as lately determined by Eichelberger and Newton from the shift in the node of the satellite; their deduced position for the planet's north pole was R.A. 295°·2, N.Decl. 41°·3, equinox 1900·0.

Seven spectrograms were obtained between Feb. 17 and May 30, 1928. They all showed the spectral lines inclined in the same sense, and gave $2{\cdot}76 \pm 0{\cdot}15$ km./sec. as the linear speed of a point on the equator. Taking the circumference of Neptune's equator as 157,000 km., they deduce 15·8 hours as the rotation period, with a probable error of 1 hour. This result makes it probable that the values $7^h\ 55^m\ 12^s$, and $7^h\ 50^m\ 6^s$ found by Maxwell Hall in 1883 and 1915 respectively, and those found a few years ago by Opik and Liviander at Tartu, $7^h\ 42^m\ 24^s{\cdot}1$ and $7^h\ 50^m\ 10^s{\cdot}7$, were really the half period. The latter were found by periodic variation in the planet's light; if opposite hemispheres happened to resemble each other, the light would vary in half the rotation period. Twice the mean of the four values is $15^h\ 38^m\ 56^s{\cdot}4$, which is very close to the new value. The longer value is supported by dynamical considerations, Dr. J. Jackson having shown, in *Mon. Not. Roy. Ast. Soc.* for March 1926, that the 7-hour period would imply a degree of oblateness in the planet much greater than that indicated by the shift of the node of the satellite. He found a period of 19·1 hours, but with a probable error of nearly a fifth of itself, so that the new value is not too discordant from it. The most surprising result of the new investigation is that the rotation of Neptune is direct, that is, in the same direction as the earth, and the opposite direction to the revolution of the satellite. The seven spectrograms are all in agreement on this point. In all other cases in the solar system, except the very remote outer satellites of Jupiter and Saturn, rotation and satellite movement are in the same sense. Moore and Menzel found that the shift in latitude 45° was $\frac{7}{10}$ of that at the equator, while that at the poles was almost zero; these results support the correctness of the assumed position of the planet's equator.

PHOTOGRAPHS OF VENUS.—The photography of Venus in light of different wave-lengths was undertaken by Mr. F. E. Ross during a very favourable elongation in June–July 1927, using the Mount Wilson 60-inch and 100-inch reflectors. A paper describing his results, and including a useful résumé of previous work on Venus (both photographic and visual), appears in a recent issue of the *Astrophysical Journal* (vol. 68, p. 57). Owing to the greater penetrating power of long waves, it was hoped that photographs taken by red or infra-red light might show some details of the true surface; it was found, however, that such photographs actually showed no detail, whereas many markings were clearly visible in photographs taken in ultra-violet light. The author suggests as a tentative explanation the existence of a very dense yellowish lower atmosphere above which lies a thin stratum of cirrus cloud. The ultra-violet photographs (which are well reproduced on two plates) show much variable detail, assumed to be due to atmospheric disturbances in the upper layers. The photographs appear to require a short rotation period, inconsistent with spectroscopic data, and a period of about 30 days is suggested as the best compromise which can be made at present from all existing data.

THE ORBIT OF μ' HERCULIS.—The work of E. Silbernagel on the orbit of ζ Herculis was recently mentioned in this column. He contributes a paper on μ' Herculis to *Astr. Nach.*, 5583. The observations used extend from 1857 to 1926, without any considerable gaps, and cover more than one and a half revolutions. The final period is 42·87 years, periastron 1879·42, semi-major axis 1·29″, eccentricity 0·183. A second solution, with slightly different values, represents the observations of distance somewhat better. Systematic corrections are determined for six of the observers.

Research Items.

BRONZE AGE AND LATER BURIALS AT DUNSTABLE.—A further report on the excavations of the University College (London) and the Hospital Anthropological Society at Dunstable on No. 5 Barrow, Five Knolls, appears in *Man* for September. The whole of the central area and a large part of the periphery of the mound have now been excavated down to the undisturbed chalk. Twelve secondary interments by inhumation were found, including a large multiple burial near the north-east margin of the barrow, making twenty-two superficial burials by inhumation on this site in all. The evidence points to the barrow having been erected in the Bronze Age. The primary burial contained a woman of neolithic type, while the urn containing cremation No. 1 was deposited in the Middle Bronze Age, and No. 2 probably dates from the latter period, though there is no evidence. It is likely that the barrow was used as a burial place in Saxon times. The superficial burials were all very near the surface, one being so little as three inches only below it. The archæological evidence for dating them is very scanty, but, accepting a coin as indicative of date, the end of the third century A.D. may be taken as the limiting date, but there is nothing to show how much later they may be. The careless method of burial suggests a place of execution. The disturbance after burial in many cases is probably recent. All the adult male skulls are large and muscular. One is dolichocephalic, six mesolicephalic, and four brachycephalic, the index ranging from 74·7 to 83. The average from the multiple burial is 79·9, and of the other male skulls 78·6. The average for the Saxon skulls in the London museums is 74·7, and it is therefore possible that the Dunstable skulls show signs of Alpine admixture. The jaw is larger and broader than the usual Saxon type, and the nasal index higher (average of 7 males, 50·6). On the other hand, the greater basiobregmatic and nasobasion length characteristic of the Saxon type is present, distinguishing it from the Iron Age and Romano-British type. The teeth are large and regular; two have an edge to edge bite. Seven adult males show caries.

OXYGEN AND CANCER.—Warburg and his collaborators have shown that malignant tissues differ from normal tissues in the character of their respiratory processes: the tumour cells obtain their energy chiefly from glycolysis with the consequent production of lactic acid, whereas in the respiration of normal cells oxygen is utilised and the end products of combustion are carbon dioxide and water. A normally growing cell also shows glycolytic activity, but the accompanying utilisation of oxygen suffices to break down the products of this activity into the ultimate end substances of oxidation. Warburg therefore suggests that the causative factor in the origin of tumours is deficiency of oxygen. Such a conclusion calls to mind that Mr. Lionel Cresswell put forward the same view so far back as the year 1914 (*Nineteenth Century and After*, May 1914) as the *Spectator* of Sept. 29 points out. He suggested that a variety of agents might be the immediate cause of a deficiency in the oxygen supply to a cell or group of cells, such as injury, senility, etc. If active nascent oxygen were supplied to these cells, presumably by means of some catalytic agent, they might be expected to seize on it avidly, and so increase their oxidative processes that the food supply reaching them by the usual channels becomes insufficient and they are led to prey upon their neighbours, which, being uninjured, are still suffering from lack of oxygen. Although in its details the hypothesis may not be completely borne out by the facts of experiment, yet the central idea of a lack of oxygen being the essential stimulus to the development by a cell of malignant characteristics appears confirmed by the work of Warburg. The corollary is that an adequate supply of oxygen to tumour cells should inhibit their disordered growth, and Wasels has found in mice that cure of malignant growths has followed the respiration of a mixture of oxygen and carbonic acid, accompanied by the injection of certain preparations of iron. It is possible that these observations may provide the explanation for certain cases of spontaneous cure of cancer which have been reported, as well as lead to an efficient therapeutics in the future.

TOHEROA SOUP.—Dr. John Malcolm in his paper "Food Values of New Zealand Fish, Part 9. Tinned Toheroa and Toheroa Soup" (*Trans. and Proc. New Zealand Institute*, vol. 59, pt. 1, March 1928) gives the results of an investigation of the food value of tinned Toheroa and Toheroa soup. The Toheroa (*Amphidesma ventricosum* Gray) is a bivalve mollusc living in the tideway of certain long sandy beaches, and has been recently successfully canned whole and forms the basis of 'Toheroa soup.' Experiments on feeding rats showed the mollusc to be rich in vitamin A. Similar work done on the Stewart Island oysters showed that, on the whole, the toheroas were the richer of the two, although both were valuable sources of this vitamin. The toheroa is apparently richer in chlorophyll, and it is thought this is probably due to its eating more phytoplankton, whilst the oyster eats more zooplankton.

NEW ZEALAND ALCYONARIANS.—In his paper "On Some Alcyonarians from New Zealand Waters" (*Trans. and Proc. New Zealand Institute*, vol. 59, pt. 1, March 1928) Dr. Benham describes five species, four of which are new. Only a few forms are known from these waters round the New Zealand coast, and the fauna of the deeper water apparently forms a new field for the zoologist. Of the species here described three belong to the order Alcyonacea, one to the Stolonifera, and one to the Pseudaxonia. *Clavularia thomsoni* sp. n. is attributed to this genus by the author with some hesitation, as it has many features in common with Verrill's *Anthopodium australe* growing on another Alcyonarian, *Primnoella australasiæ*. Unfortunately, no figure exists of this. *Clavularia thomsoni* is a small form which creeps over the surface of a simple coral, probably a species of *Caryophyllia*. The coral itself was covered with an encrusting sponge containing needle-like spicules and the alcyonarian polyps projected through the sponge. So densely are the polyps coated with their own spicules, which are elongated and knobbed, that the stolon is completely hidden. With the Alcyonaria a knowledge of the internal anatomy and form of spicules is essential, therefore comparison with the species of most of the older authorities, who named them from external features only, is difficult. In these descriptions full attention is given to these important points and clear text figures are included.

IDENTIFICATION AND CLASSIFICATION OF FISHES BY THEIR SCALES.—The interesting question of the usefulness of scale-characters for the identification and classification of fishes is dealt with by Miss E. B. Peabody in *University of Colorado Studies*, vol. 16, No. 2. A group of fishes, the sub-order Clupeoidei, was chosen in which, besides clearly delimited species,

there are certain species which have been classified now in one family and now in another by different taxonomists. An endeavour was made to ascertain what light on the relationship of the species could be derived from a study of the scale-patterns, and to determine whether the scales could help to decide the proper position of some of the fishes the indefinite relationships of which had been shown by their numerous changes from one family to another. Miss Peabody draws the general conclusion that scales have a diagnostic value and are distinctive of families and genera, but not always of species. Those families which have been clearly delimited by taxonomists on the evidence of the morphology of the entire fish and have not been subjected to subsequent changes of position by other workers, exhibit definite scale-characters which distinguish them from other families. On the other hand, in those groups the genera of which have been changed again and again by taxonomists, the scales reflect the indefiniteness of the family border-lines. The author rightly points out that if scales, convenient as they are for study, can yield results similar to those obtainable by the usual process, then their use in cases where the whole fish is not conveniently at hand or cannot be produced, as in palæontological work, is of importance.

BIOLOGICAL CONTROL OF WOOD-WASPS.—The accidental introduction into New Zealand of the injurious steel-blue wood-wasp *Sirex juvencus* has led to the study of the parasites of its close ally *S. cyaneus* in England. In the *Bulletin of Entomological Research*, vol. 19, part 1 (August 1928) Messrs. R. N. Chrystal and J. G. Myers describe the main features in the life-histories of the large Ichneumon *Rhyssa persuasoria* and the rare and aberrant Cynipid *Ibalia leucospoides*. They were fortunate in finding in Tubney Wood, near Oxford, which consists of a stand of larches and pines, a locality where the host and its parasites occurred in sufficient numbers to allow of regular observation. The method of oviposition of *Rhyssa* has long excited the interest of entomologists, doubt often being expressed as to the ability of the insect to penetrate solid wood with its long slender ovipositor. The authors fortunately are able definitely to answer this question and find that the insect can pierce, almost up to the hilt of the ovipositor, the soundest wood. The eggs, which are described for the first time, are laid in the burrows of almost or quite fully fed *Sirex* larvæ or the pupæ. They live as ectoparasites, and the whole life-cycle normally occupies one year. The *Ibalia* oviposits in the young *Sirex* larva just before or more rarely just after hatching, utilising the ovipositor bores of its host for the purpose. The larvæ of this parasite seem to live wholly within their hosts, and the life-cycle requires at least two years. Since the two parasites attack their host in very different stages of the latter, risk of superparasitism seems negligible, and it is suggested that both species be introduced into New Zealand as a measure against the wood-wasp *Sirex juvencus*.

RESEARCH ON MALTING BARLEY.—The Barley Research Scheme of the Institute of Brewing has as its objects the investigation of the influence of soil, season, and manure on the yield and quality of the barley, the study of new variations and the differentiation of malting barleys by chemical means. The gradual accumulation of a great mass of data during the five years of its existence has obscured a number of interesting generalisations that emerge from the results, and a recent careful analysis by Sir John Russell (*Jour. Inst. Brewing*, **34**, 436; 1928) provides a useful summary of the present position. The trials were all carried out with Plumage Archer seed and under the same system of manuring, and on average, 1 cwt. of ammonium sulphate increased the yield by about 6 bushels per acre, *i.e.* six times the increase produced by superphosphate or potassium sulphate. It seems, however, that phosphates, which cause the barley to ripen prematurely, may even produce a decrease in yield on light dry soils. The April rainfall determines whether the plant can take up its fertiliser, whilst rainfall in May and June governs the use to which the fertiliser can be put, and is detrimental when potash is used. Ammonium chloride is a better source of nitrogen than an equivalent amount of the sulphate, and produces a greater number of grains per acre although the number of grains per ear is unaltered. The actual extract and amount of nitrogen in the grain, however, are both governed principally by the soil and season, and from a consideration of the rainfall in May and June, and of the date of sowing, it should be possible to forecast the latter for a particular soil. Analyses showed that the nitrogen content varied directly with the diastatic power, and inversely with the carbohydrate content.

GREEN MANURING.—Green manures grown as cover crops vary considerably as regards the rate of accumulation of nitrates which follows their incorporation with the soil, a further variation depending upon the time of ploughing under, whether in spring or autumn. T. L. Lyon and B. D. Wilson (*Cornell Univ. Agric. Expt. Stat. Memoir*, 115) have grown vetch, rye, peas, oats, and buckwheat as cover crops for ten successive seasons on the same soil, and found that the accumulation of nitrogen during the fallow periods after turning in decreased progressively in the order given, vetch being the most effective. The advantage in this respect lay with those crops which were less advanced in growth at the time of ploughing under. Fall ploughing induced the highest soil content of nitrate nitrogen in the spring and early summer, and liming increased the accumulation, particularly with rye. During the ten years' period of experiment the soil of all plots lost in total nitrogen at the rate of 42 lb. nitrogen per acre with vetch, 217 lb. with rye, 380 lb. with peas, 382 lb. with oats, and 412 lb. with buckwheat, whereas a similar plot kept continuously under grass gained 415 lb. nitrogen per acre. The loss of total nitrogen was in inverse order to nitrate nitrogen content of the soil during the period when nitrates were highest. After the ten years all the plots were planted to maize one year and oats the next, and the combined yields of the two crops were in inverse order to the loss of total nitrogen in the soil. As a means of mitigating the loss of fertility indicated by these results, it is suggested that (1) the land be laid down to grass for a period of years, and (2) those legumes be cultivated which are most active in fixing nitrogen, for example, vetch, but not field peas.

IODINE FROM MARINE ALGÆ.—The re-establishment of an industry based on the utilisation of marine algæ would be of very great economic importance for the inhabitants of the west coast of Ireland. T. Dillon and E. F. Lavelle (*Econ. Proc. Roy. Dublin Soc.*, September) suggest a process whereby various products can be recovered, which is simple enough in its initial stages to be operated locally all the year round. The idea is to collect the seaweed, chiefly Laminariæ, in reservoirs exposed to the weather and to allow it to decay. The resulting liquid, rich in iodine, potash, and organic matter, would be drained off at intervals, concentrated locally, and dispatched to a central factory for final treatment. Small scale experiments, in which 31 kilograms of Laminariæ were allowed to decay in the open for seventeen weeks, showed that the bulk of the iodine present was ex-

tracted in that time, about 70 per cent of the mineral matter, and 29 per cent of the total solids. Very little nitrogen was obtained by this method. After nine months a certain proportion of seaweed remained incompletely decayed, and it is suggested that such residues could be dried during the summer months and utilised as fuel for the evaporation of the extracts.

DEFORMATION OF THE SEA-BED DURING EARTHQUAKES.—Messrs. T. Terada and S. Higasi have studied the deformation of the sea-bed in three recent Japanese earthquakes. In the Tango earthquake of 1927 (*Tokyo Imp. Acad. Proc.*, vol. 4, pp. 296-299; 1928), a comparison of soundings before and after the earthquake revealed a zone of depression (of more than 3 metres) parallel to the coast-line and at a distance of 1-3 km. from it, beyond which there was a broader zone of upheaval. In the Tajima earthquake of 1925 and the Kwanto earthquake of 1923 (*ibid.*, pp. 364-366), there was formed first a zone of depression, then a zone of upheaval, both parallel to the coast-line, succeeded by another area of depression. This tendency of the sea-bed to be deformed in alternate zones of depression and elevation parallel to the coast-line suggests, in the authors' opinion, that there is some essential difference in the structure of the earth's crust even between the land-area and the shallow shelf of the sea-bed.

ANCIENT VOLCANOES OF BURMA.—During the last four years Dr. H. L. Chhibber, of Rangoon, has published a long series of papers (in some cases in collaboration with others) dealing with the records of Tertiary volcanic activity in Burma. A convenient summary and map is now presented in the *Journal of the Burma Research Society* (vol. 17, p. 169, 1927). The volcanoes of Burma show a remarkable linear arrangement, but up to the present the erroneous idea of a single volcanic line has prevailed; actually, there are four main lines. The western line is connected with the Arakan Yomas and the Andaman Islands, and includes many serpentine intrusions. The eastern line lies on the Shan plateau, and another line lies close to the edge of the plateau; the rocks of these include rhyolites and basalts having Atlantic characters. Finally, there is the best-known central or Popa line of volcanoes, including the centres of Mt. Popa, Monywa, and Wuntho. Barren Island and Narcondam represent the seaward continuation of this line, which is everywhere characterised by dolerites or by basalts, andesites, and related rocks of Pacific types. Beginning in the late Cretaceous, activity has continued at intervals up to almost historical times. It is noted throughout the country that the volcanoes have broken through in or near valleys and have avoided ridges or hills.

THE GREAT WHIN SILL.—An important paper by Prof. A. Holmes and Dr. H. F. Harwood on the age and composition of the Whin Sill and the related dikes of the north of England, appears in the *Mineralogical Magazine* for September. The post-Westphalian dikes of the district may be classified by their orientations into two clearly defined series. One of these consists of quartz-dolerites of the Whin Sill type in late Carboniferous dikes running east and west or north of east, whereas the other consists of Tertiary tholeiite dikes running north of west towards Mull. The Whin Sill dikes fall into four echelons, the Holy Island, High Green, St. Oswald's Chapel, and Hett systems. Chemical and mineral analyses of typical examples of each of these (and of the Wackerfield dyke to the south) prove that they and the Whin Sill are composed throughout of substantially identical material. It is shown that the magma-type is one of world-wide continental distribution, and that it is a nearly constant end-product towards which basaltic magma tends to differentiate under regional conditions. Under the central conditions of oceanic islands, differentiation follows a totally different course. The cooling history of the pyroxenes is worked out with special care, and the results are interpreted to indicate that some of the Tertiary dikes of Mull may represent a basaltic magma *diluted* with granitic magma rather than a residual magma produced by crystallisation-differentiation of the type advocated by Bowen. Prof. Holmes discusses the significance of his discovery of a pebble of the Whin Sill type of quartz-dolerite in the Upper Brockram near Appleby. This and other evidence leads him to conclude (*a*) that the intrusion of the Whin Sill and the related dikes followed closely on the Asturian phase of the Hercynian movements (between Westphalian and Stephanian); and (*b*) that the later mineralisation of the north of England (lead-zinc-fluorite-barytes, etc.) was associated with the Saalian movements (between Autunian and Saxonian). The injection of the Whin Sill and dikes is thus regarded as the closing act of the Upper Carboniferous in the north of England.

CRYSTALLOGRAPHIC TABLES.—The attention of mineralogists is directed to a useful publication by Victor Goldschmidt and S. G. Gordon, in which the determined crystallographic constants (angles and axial ratios) of all minerals are listed. The pamphlet is issued by the Academy of National Sciences of Philadelphia as *Special Publication No. 2*, 1928, at a price of 1.50 dollars. Details are tabulated for 1217 mineral species, and the chemical composition, specific gravity, hardness, cleavage, etc., are stated. The tables are based on the Goldschmidt two-dimensional gnomonic method and symbols, of which a brief explanation is given in the introduction.

A NEW MAGNETIC ALLOY.—The September issue of the *Journal of the Franklin Institute* contains an account by Mr. G. W. Elmen, of the Bell Telephone Laboratories, New York, of the magnetic properties of the new alloy 'Permivar,' of composition nickel 45 per cent, cobalt 25 per cent, and iron 30 per cent. When properly heat-treated, its magnetic permeability is initially double that of iron and is constant for fields up to 2 gauss. Its hysteresis loss per cubic centimetre per cycle for a magnetic induction of 100 gauss is only $2{\cdot}4 \times 10^{-5}$ ergs, while that of permalloy with 78 per cent of nickel is $3{\cdot}3 \times 10^{-2}$, and that of iron of the order of 1 erg. Slow cooling through the range of temperature 500°-400° C. and baking for a considerable time at 425° C. appear to be necessary for the development of the characteristic properties of the alloy, which is likely to prove of great value in the cores of loading coils for telephone circuits.

RADIO TIME SIGNALS.—The daily time signals transmitted by the radio stations at Rugby, Bordeaux, Nauen, and Annapolis are generally accepted by surveyors as accurate, for their errors rarely exceed one-tenth of a second. At the Conference of Empire Surveyors held last July, it was suggested that it would be useful to have published the corrections to Bordeaux, Nauen, and Annapolis, as determined at Greenwich. Corrections to the Rugby signal are published a month in arrear in the Admiralty *Notices to Mariners*. The *Geographical Journal* for October reports that the suggestion of the Conference has been adopted and that *Notices to Mariners* now contains the corrections. The greatest correction to Rugby during July was 0·04 s. and to Bordeaux 0·12 s., and the averages without regard to signs 0·019 s. and 0·039 s. respectively. The correction to Annapolis was uniformly positive with a mean of 0·074 s.

The Forest Industry of Finland.

IN a recent number (No. 8, 1928) of the *Oxford Forestry Memoirs*, Mr. W. E. Hiley discusses the "Forest Industry of Finland," his brochure being based on a visit to the Finnish forests last year. It has become a curious practice with some of the younger writers on forestry questions to treat pre-War investigations as either non-existent or of little importance. Thus in his paper Mr. Hiley writes: "Much has been written in the English language about Finnish forestry and the timber trade, and English readers can acquire a good general knowledge of these subjects without leaving Britain. But so far, very little information has been available with regard to the economics of Finnish forestry." Mr. Hiley does not define his term 'economics,' but a perusal of his interesting memoir fails to exhibit any marked departures from the lines of articles which appeared in 1911 in the publications of the Geographical Society of Finland. Several of these articles were from the pens of experts such as Prof. A. K. Kajander, P. W. Hannikaiven (then Director-General of State Forests), and A. B. Helander (Inspector of Forests). These articles were dealt with in the English press and in some cases by men who had a personal acquaintance with the Finnish forests.

Although, as Mr. Hiley says, the State forests of Finland are mainly confined to the northern parts of the country, the richer and better forests to the south being largely in private ownership, yet by 1910 the annual receipts from the State forests amounted to £660,000 with an expenditure of £195,000. Under the Czarist regime, however, the policy towards Finland was one of repression in industrial development, and the forest administration was starved. It may be mentioned that the species consist principally of Scots pine, spruce, and white birch, with a little aspen, grey alder, and pedunculate oak.

Since 1917, when Finland freed herself from Russia, there has been a remarkable progress in forest development and timber exploitation on up-to-date lines, with the result that at the present time she is one of our best suppliers of soft woods and has taken a leading place in the European timber markets. This development, and the startling rapidity with which it has proceeded, has proved of high interest to those acquainted with the country and its pre-War position. Mr. Hiley has taken full advantage of the opportunities so kindly afforded him by the Finnish Government officials, and his memoir will prove of value to all interested in this matter. It will suffice here to indicate some of the main divisions of his subject; namely, ownership of the forests, administration (State forests, joint stock company forests, private forests), sylviculture, felling and extraction, sawmills, economics of forest management, costs and prices, and finally a few remarks on the forest policy of Finland. The latter are of special interest, since the author here gives us the present-day forest policy of the Government.

The State recognises that its first duty is to maintain the timber increment (the forests providing the most important of Finnish exports) so as to preserve the great timber industry of the country, whilst maintaining the necessary supplies of wood for home consumption. In 1926 the value of timber and other forest products exported amounted to 85·4 per cent of all Finnish exports. As regards home consumption, all who have visited the country will have been struck by the universal use of timber. Outside the larger cities all buildings are almost entirely constructed of wood. It is estimated that 60 per cent of the wood felled is used in the country, representing a *per capita* consumption of 260 cub. ft. per annum, or about ten times more than the consumption in Britain. Wooden fences replace hedges, and the railway engines are of course fuelled with wood, coal being too expensive. The new policy in the State forests is to take an increasing share in the conversion of timber, whereas formerly the trees were sold standing, or felled and hauled to the rivers. The State now owns a controlling share in two important timber companies and has several sawmills of its own, including a large and modern mill at Veitsiluoto at the mouth of the Kemi River, in the extreme north of the Gulf of Bothnia.

The income from, and expenditure on, the State forests has increased progressively since the country became independent and a more rational policy was introduced, the figures for 1924 being respectively about nineteen and twenty-eight times the amounts for 1910. Some dissatisfaction is being manifested at the State entering into competition with the mercantile community; but in the present stage of this important industry in the country the policy would appear to be a sound one. In conclusion, Mr. Hiley's brochure may be commended as meriting a study by all interested in the soft wood timber trade.

Chemical Analysis in the Public Service.

'SAFEGUARDING'—in a non-political sense; safeguarding of health, of justice, and of revenue—relies to an ever-increasing extent on the services which can, under cautious yet confident direction, be rendered by chemical science. The report of the Government Chemist for the year ending Mar. 31, 1928, abounds in examples of such service to the various departments, and in certain respects to the Government of Northern Ireland, the High Commissioner for India, the Crown Agents for the Colonies, the Dominions Office, the Corporation of Trinity House, the Commonwealth of Australia, and the High Commissioner for Southern Rhodesia. The work for most of the departments is carried out at the laboratory at Clement's Inn Passage, London; the laboratory at the Custom House naturally deals specially with customs samples, some of which, together with excise samples, are examined at chemical stations established at the more important seaports. In addition, the laboratory at the Geological Survey Museum is maintained, and work for the War Office is performed at the Supply Reserve Depot laboratory at Deptford.

The total number of samples examined during the year was 491,039, an increase of 21,397 over that of the preceding year. In addition to this purely routine analysis—if such a term can be properly applied to so heterogeneous a collection of samples, involving the most varied and detailed methods of examination—a considerable amount of work has been done in connexion with the revision of existing methods and the investigation of new methods of detection and determination of substances; moreover, the Government Chemist (Sir Robert Robertson), his deputy, and staff serve on various official committees, and from time to time are called upon to give evidence in legal proceedings.

The report shows, for example, that exceptional care is necessary in the sampling of milk supplied in bottles, the absence of air space rendering mixing difficult; that forty samples of fresh milk in churns imported from the Continent were satisfactory; and

that although only 45 per cent of the samples of imported cheese examined had been prepared from whole milk, in the absence of regulations relating to the marking of skimmed milk cheese no action could be taken in respect of the remainder. On the other hand, out of 69 samples of condensed milk or milk powder, seventeen had been prepared from skimmed milk without being so declared on the package, as required by law.

More than fifty samples of river water, muds, and effluents were examined from the point of view of fish life and the effect of pollution on fish and fish food. Incidentally, North Sea herring and sea water were found to contain traces of arsenic. A sheep's jawbone containing teeth with a metallic lustre, popularly believed to be a deposit of gold, was examined; the metallic sheen appeared to be due to the effect of light on a laminated crystalline structure mainly composed of calcium phosphate. In 50 per cent of the samples of non-alcoholic beer the amount of proof-spirit present exceeded the legal limit of 2 per cent, and 14 out of 36 samples of herb beer, ginger beer, etc., contained alcohol ranging from 2 to 5 per cent of proof spirit.

The silk and artificial silk duties have in many cases necessitated much detailed examination of goods. Saccharin is searched for in all likely preparations, and is indeed found in a large proportion of imported substances, usually containing some other dutiable ingredient. Large stocks of tea in bonded warehouses on the banks of the Thames had to be re-examined on account of damage caused by floods. It is also worth recording that more than 200 milligrams of radium were recovered during the year from accumulated stocks of disused luminous compass dials etc., and the product was concentrated into a high-grade salt.

The Embrittlement of Boiler Plates.

IN the issue of NATURE for May 7, 1927, p. 686, an account was given of work which had been carried out at the Experimental Research Station of the University of Illinois over a period of several years. The authors, S. W. Parr and F. G. Straub, showed that the embrittlement of boiler plates takes place as a result of the simultaneous action of a tensile stress exceeding the elastic limit, and of a concentrated solution of caustic soda. The amount of the latter required exceeds, however, anything which could normally be present in the boiler water itself, but this concentration can occur in the seams where the plates have been riveted together, and it is in this locality that embrittlement cracking takes place.

Bulletin No. 177 by the same authors confirms the earlier work, both by laboratory tests and in actual boiler practice, but carries the question of the inhibition of the embrittlement a good deal further. It was shown in the earlier paper that, provided the amount of sodium sulphate in solution in the water was sufficient, embrittlement could be prevented. The American Society of Mechanical Engineers has recommended, therefore, that the water in boilers should be maintained with a ratio of sodium sulphate to total alkalinity, calculated as sodium carbonate, of not less than the following: For a working pressure in the boiler up to 150 lb. per square inch, 1 to 1; from 150 lb. to 200 lb. per square inch working pressure, 2 to 1; and above 250 lb. per square inch, 3 to 1. It is doubtful whether any case of brittleness has ever been observed in boilers where these conditions have been fulfilled.

The authors in their later paper have pointed out in a very clear manner the danger which may ensue as the result of the addition of water-softening materials, such as soda ash or zeolite, in the absence of adequate supervision, and give numerous examples of failures in boilers which have resulted from the use of these materials without proper control. From the very large number of cases of boiler embrittlement which have come under their examination, the authors state that 10 per cent only were the result of embrittlement by natural water, 20 per cent occurred with water treated with soda ash, and no less than 70 per cent with water treated with zeolite. The presence of sodium chloride in the boiler water is also shown to accelerate the attack very greatly.

Attempts to prevent the formation of caustic soda in the boilers by the addition of organic matter have been made, but with no success in the authors' hands, since it is impossible appreciably to retard the decomposition of the sodium carbonate by this means. Apparently the most successful method of preventing brittleness is by the addition of soluble phosphates: a solution of sodium phosphate containing 0·6 gram of the PO_4 radical per litre has been shown to prevent cracking even where a steam pressure as high as 500 lb. per square inch has been used, and where the mild steel has been subjected to a tensile stress of 45,000 lb. per square inch, together with a concentration of sodium hydroxide of roughly 300 grams per litre. In a check experiment, using the same conditions apart from the addition of the phosphate, fracture occurred in the steel in twenty-four hours. It is stated that a United States patent has been taken out to cover this use of sodium phosphate. Other substances, such as chromates, tannates, acetates, etc., may also possess value in this connexion.

The authors have been unable to find any steel, otherwise suitable for boiler plates, which is resistant to the embrittlement resulting from the simultaneous action of stress and caustic soda attack.

The Public Health.

THE ninth Annual Report of the Ministry of Health, 1927–28,[1] is a mine of information on various aspects of the public health. It is divided into five sections, one of which comprises the report of the Welsh Board of Health, and a series of appendices. The five main divisions deal with the public health, local government and finance, administration of the poor law, and National Health Insurance and Contributory Pensions. Among the general subjects in the section on public health, reference is made to the coming into force of the Therapeutic Substances Act, 1925, and the passage of a Bill through Parliament to amend the Mental Deficiency Act, 1913, to allow of the treatment of young persons suffering from the after effects of encephalitis lethargica: mental defectiveness is now defined as a condition of incomplete development of mind existing before the age of eighteen years, whether inherent or caused by disease or injury. Work has also been commenced to investigate the causes of maternal mortality and puerperal fever: the maternal mortality rate has been almost stationary in Great Britain for the last twenty years, indicating that special efforts must be made to reduce it.

In the section on the inspection and supervision of food, it is noted that the demand for milk of high hygienic quality continues to increase. Although the addition of preservatives to articles of food is now restricted, a few samples out of the large number taken, chiefly sausages and other meat products, were

[1] "Ninth Annual Report of the Ministry of Health, 1927–28." Pp. 292+xviii. (London: H.M. Stationery Office, 1928.)

found to contain excess of, or forbidden, preservatives. Some canned vegetables were found to contain a copper colouring matter. Of 124,264 samples of food taken for analysis, 5·5 per cent were found to be adulterated, or not up to standard: no milk samples contained preservatives, but six contained colouring matter, and forty-four dirt: the chief defect in these samples was failure to reach the required standards. A few samples of butter were found to consist wholly or partly of margarine: some contained excessive amounts of preservatives and others of water: no sample of margarine was found to contain any mineral oil. Some samples of lard contained vegetable fat, and some of suet an excessive amount of rice flour or starch. Among other adulterants found in different articles of food were arsenic in flour, glass in lemon crystals, lead in aerated waters, phosphoric acid as the chief constituent of a "pure raspberry cordial," and boric acid in continental sweets: some samples of egg powder consisted merely of coloured baking powder, and a coloured and flavoured solution of sugar in water found a sale as "black currant wine." These results show the necessity of keeping a watchful eye on the purity of the nation's food supply.

Among the infectious diseases, mild smallpox remained prevalent, but the fatality rate for diphtheria and scarlet fever showed a considerable decline: the number of cases of encephalitis lethargica also decreased, but the fatality rate was higher.

In the section on public health will be found reported also the progress of maternity and child welfare schemes, housing and town planning. The section on the administration of the Poor Law gives an interesting account of a subject which is of great importance to the country at the present time: it is of interest to note that there is a large increase in the numbers of those seeking out-relief at the time of a general holiday. The working of the National Health Insurance and the Pensions scheme is fully described in the last section of the report, which is altogether a valuable compendium of the many-sided aspects of the public health.

University and Educational Intelligence.

BRISTOL.—The first Henry Herbert Wills Memorial Lecture, founded to commemorate the gift of the Physical Laboratory to the University, will be delivered by Sir James Jeans on Oct. 30 at 5.30 P.M. The title of his lecture will be "The Physics of the Universe."

KING'S COLLEGE, University of London, is this year celebrating the centenary of its foundation, and an appeal is being issued for £350,000 to enlarge the College and to provide a much-needed endowment. Of this sum about £100,000 is needed to endow special chairs and studentships in physics, physical chemistry, electrical engineering, and physiology. Before the War, the full-time day students in attendance at the College numbered about 700. Now there are more than 1200 undergraduate students, more than 300 postgraduate students, and about 500 evening students. Another new and important development since 1913 has been the annual scheme of free public lectures by means of which the latest discoveries in science and learning have been made accessible to large popular audiences. This increase in numbers and the modern requirements of teaching and research are making new demands which must be met. Among the most pressing needs are the construction of a new Anatomy Building in proximity to the physiological laboratories and the reconstruction and extension of the chemical laboratories, which will cost £125,000. Donations should be sent to one of the treasurers, the Right Hon. Reginald McKenna, or Sir Edward Troup, at King's College, Strand, W.C.2, or to the College Bankers, Messrs. Coutts and Co., at 440 Strand, W.C.2, for the credit of King's College Centenary Appeal Account.

THE 'land-grant' colleges and universities of the United States had in 1926 nearly three times as many students (not including pre-matriculation, summer school, extension, or correspondence students) as the universities and university colleges of Great Britain, and more than one-fifth of the total college and university enrolment of the United States. Full statistics regarding them are to be found in *Bulletin No. 37* of 1927 of the United States Bureau of Education. The Land-Grant Act of 1862, known as the first Morrill Act, allotted to the States of the Union more than ten million acres of public lands for the establishment in each State of a college in which the leading object was to be "to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life." Thus with admirable foresight was machinery created for ensuring that the United States should be well equipped after the Civil War for the coming international rivalry in industry. During the present century, and especially during the years from 1915 until 1926, the progress of these institutions has been astonishingly rapid. Their student enrolment increased during those ten years by 150 per cent, whilst their total annual receipts increased from 36 to 124 million dollars. On experimental stations (chiefly agricultural) and other organised research work, the annual expenditure exceeds ten million dollars. It is largely through the work of their agricultural experiment stations, first established in 1887, that the land-grant colleges are contributing towards the general adoption in American agriculture of scientific organisation in place of the haphazard and traditional methods of the past.

IN "Rural Education in England and the Panjab" (*Occasional Report* No. 15 of the Bureau of Education, India) two members of the Indian Educational Service describe impressions received in the course of a three-months' tour throughout the length and breadth of England, and make instructive comparisons with conditions in the Panjab, and suggestions for creating a genuinely 'rural atmosphere' in village schools in that province. The 'rural bias' question which has been so much in evidence of late in conferences on education in England, is a hundred-fold more important in India, owing to the immense preponderance of agricultural as compared with urban occupations, the much deeper cleavage between village and urban life, and the hitherto almost exclusively urban bias of the teacher-training institutions and inspectorate. Attempts, begun more than forty years ago, to popularise and vitalise the town-made teaching in the country districts of the Panjab, proved ineffectual until, soon after the War, school farms were introduced. Of the reforms recommended in the present report, the most important have to do with the training of village teachers. In selection of candidates, more consideration should be given to health, physique, caste, and domicile, and the duration of the course should be increased from 9 months to 18 or 24 months. Appended to the report are a useful comparison of rural science teaching in primary schools in Ireland with similar teaching in the Panjab, and an account of a new School of Rural Economy at Gurgaon, where students are trained, not for teaching in schools, but for moving from village to village, showing (by practice as well as precept) how the people may improve their conditions of life.

Calendar of Customs and Festivals.

October 28.

ST. SIMON AND ST. JUDE'S DAY.—A day which in popular tradition was specially associated with a downfall of rain. It was said that in 1536 a battle between the king's troops and the rebels in Yorkshire was prevented by the heavy fall of rain which took place on the eve of this day.

On this day the paring of a whole apple thrown over the shoulder by the right hand, while the inquirer stands in the middle of the room and repeats the appointed verses, will form the first letter of the surname of the future husband, but if it breaks, the inquirer will never marry. The apparently meaningless addition that the pips of the apple should be put in spring water and drunk, for which no reason is given, betrays the charm.

October 29.

ST. MODWEN'S DAY.—Observed as a fair for the sale of cheese at Burton-on-Trent.

October 30.

From this day until Nov. 7 at Chetwode, the Lord of the Manor had the right to levy 'Rhyme Toll' on all cattle found within the hundred. The period was proclaimed by the blowing of a whelk shell at certain prescribed points. The tradition is that the toll is a grant to the Lord of Chetwode for having rid the district of a savage boar.

October 31.

HALLOW'S EVE, the vigil of All Saints' Day, is marked by a number of the observances usually occurring in a period of transition from one season to another in the popular calendar, and thereby pointing to a pagan origin. These customs are for the most part connected with divination in various forms—at All Hallows in more variety than at any other time of the year—and the cult of spirits.

Sometimes the festival appears to have served as a final celebration of the harvest. Both nuts and apples, which in primitive Britain were the staple, and indeed almost the only, fruits, appear in the customary rites. Hallow Eve is known as 'Nut-crack Night,' and bobbing with the mouth only for apples in a bowl of water or suspended on a string is a widespread custom. At St. Ives it was obligatory that every child should receive an apple on 'Allan Day.'

Divination was practised by sticking apple pips on the cheeks, by putting nuts in the fire, by pulling oat-straws from the stack, by sowing hemp seed, and in many other ways. In Scotland cabbages were drawn from the ground by girls blindfold, the ground around the roots being the basis of interpretation; while simulation of the action of winnowing the corn with a winnowing fan in a barn, after lifting the doors from the posts, it was believed, would cause an apparition to appear and pass through the barn.

In the Celtic calendar Samhain (Nov. 1) marked the opening of the winter, the period among a pastoral people when the cattle are brought in from the hills to the fold. At this time it was customary, not only in Britain but also throughout the whole of Europe, for bonfires to be lighted. This practice survived in the custom of the master of the house carrying a bunch of lighted straw around the fields. This drove away the witches and averted their evil influence. In Scotland a fire stick was waved about with the same object; while in Lancashire, where the famous Lancashire witches gathered in the Forest of Pendle on this night for their terrible rites, the custom was observed of 'leeting' or 'lating' the witch by carrying about a candle on the hills from eleven to twelve o'clock. In Ireland a lighted candle was placed in every window. These customs are to be regarded as survivals of the Samhain fire; but there are many other cases which are more obvious. In the Isle of Man *Sanin* was observed by kindling a fire with ceremony to avert the evil influence of witches and fairies.

In many localities where the lighting of bonfires is recorded, their character is often emphasised by the fact that the bystanders danced round them or leaped through them—a familiar pagan rite still practised among primitive peoples. Pebbles also were cast into the fires, whether they were found intact or had split into fragments which could not be identified the next morning, determining the fate of the person after whom the pebble had been named.

The 'witches' against whom the fire in peasant custom is directed in a more primitive stage of belief are the spirits, and especially the spirits of the dead. This is shown by the Church's cult of All Souls' on Nov. 2, by the custom of baking a 'soul cake,' and by the practice of children going 'a souling,' that is, of going from house to house begging 'soul cakes.' In Ireland it is recorded, though perhaps not on very good authority, that parties went from house to house reciting verses which called upon the inhabitants to bring forth the 'black sheep,' an allusion to a sacrifice to the dead on the following day of Samhain, for which a *black* sheep would be the appropriate victim.

In Morocco the period beginning about the month of October is regarded as blessed. Butter churned, wheat sown, and lambs born at this time have special virtue, and are reserved for the entertainment of special guests, a small quantity only being sufficient to satisfy them. There is a saying that if October milk, butter, wheat, and lamb come together in the same dish in October, the dish will break.

November 1.

ALL HALLOWS. ALL SAINTS' DAY.—A festival originally celebrated on May 1, and afterwards moved to Nov. 1, a fact which in itself would be sufficient to make it clear that the Church had taken over an earlier pagan celebration while continuing the custom of lighting fires on the hill-tops. The reason for the transference may have been that not only was the eve of Nov. 1 the great pagan festival of the cult of the dead, but also in all probability it, rather than Beltane on May 1, was the beginning of the Celtic year. In the Isle of Man they sang a song greeting the day as the New Year. In Ireland all fires were extinguished at Samhain and a sacred fire kindled from which all the fires in the kingdom had to be relighted. It is also significant that there is a more frequent and varied practice of divination at this than at any other festival of the year.

There is a suggestion of a Samhain sacrifice in the custom recorded in the parish of Lymm where a horse's skull was gaily decorated with ribbons, fastened on a short pole and carried by a man covered with a horse cloth. Sometimes the horse was led by a chain through its lip held by another in the procession by which the 'horse' was escorted from house to house. At Chester a similar 'horse,' known as 'Old Hob,' was led about the town from All Souls' until Christmas.

November 2.

ALL SOULS' DAY.—Dedicated by the Roman Church to services for the repose of the dead. In popular observance it is marked by the making of soul cakes, blessing beans, and other customs, including the nut and apple omens and the lighting of fires which carry on the practices of All Hallows.

Societies and Academies.

LONDON.

Optical Society, Oct. 11.—Col. J. W. Gifford: Lenses and equipment for ultra-violet photography. A description is given of the type of photographic doublet generally known as rapid rectilinear, in which (1) fluorite and quartz, (2) quartz and calcite, are substituted for the ordinary crown and flint glasses. These doublets are therefore more or less transparent to the ultra-violet as well as to the visual spectrum. Corresponding lists of focal lengths for twenty-one wavelengths are given, as well as the radii, thicknesses, etc., for construction. A cement transparent to the ultra-violet for use with these lenses is described, and photographs of the spectra transmitted by certain light filters are given.—**H. Boegehold:** Some remarks on old English objectives. Constructional data, refractive indices, and ν values for the objective of an old Ramsden telescope are given with historical notes.—**Thomas H. Court and Moritz von Rohr:** On the development of spectacles in London from the end of the seventeenth century (first paper on the Court collection). English spectacles before 1666 are very imperfectly known. After the Great Fire, horn spectacles with rigid and with split frames were advertised, and leather-framed and hinged spectacles appeared. This period witnessed Marshall's improvement in grinding and polishing a number of surfaces at the same time. In the eighteenth century the London artisans became the leading spectacle opticians, as they developed the temple spectacles and very efficient nose spectacles in horn and steel, and leather and steel. Walker's untenable objections to Wollaston's periscopic spectacles are treated. The nineteenth century was not favourable to the master craftsman in London, as large spectacle factories altered the position of the spectacle vendors.

Diary of Societies.

FRIDAY, OCTOBER 26.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botanical Lecture Theatre, Imperial College of Science and Technology), at 2.30.—R. N. Chrystal: The Biology of *Sirex cyaneus* and its Parasites.—K. St. G. Cartwright: Notes on a Fungus associated with *Sirex cyaneus*.

ROYAL SOCIETY OF MEDICINE (Disease in Children Section), at 5.—Prof. Taillens: Dyspepsia in Children.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—Dr. A. Ferguson and J. P. Andrews: An Experimental Study of the Anti-clastic Bending of Rectangular Bars of Different Cross-Sections.—B. S. Smith and F. D. Smith: An Instrument for the Production of Known Small High-Frequency Alternating Electromotive Forces.—Demonstration by H. F. T. Jarvis of a New Device for Thermostatic Control.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: The Development of the Human Foot and its Bearing on Club-foot—illustrated by specimens.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 6.15.—Prof. S. Parker Smith: Ignition Systems in Automobiles.

INSTITUTION OF CHEMICAL ENGINEERS (at Institution of Civil Engineers), at 6.30.—Prof. A. L. Mellanby: Fluid Jets and their Practical Applications.

INSTITUTION OF LOCOMOTIVE ENGINEERS (at Hotel Metropole, Leeds), at 7.—E. de H. Rowntree: Glimpses of Colonial Railway Conditions.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (Chemical Section), at 7.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—R. C. Macdonald: Mechanical Plant in Gas Works.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Students' Section) (at Armstrong College, Newcastle-on-Tyne), at 7.15.—L. B. Harmer: Post Office Telephones and the Public.

MANCHESTER ASSOCIATION OF ENGINEERS (at Engineers' Club, Manchester), at 7.15.—J. S. G. Primrose: The Microscope as applied to Engineering.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—G. W. Tookey: Legal Protection for Originality and Invention.

ROYAL SOCIETY OF MEDICINE (Epidemiology Section), at 8.—Dr. F. E. Fremantle: The Authority of Parliament in Relation to Epidemic Disease (Presidential Address).

SATURDAY, OCTOBER 27.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Yorkshire District) (at Town Hall, Pontefract), at 1.45.—W. H. Newton: Notes on the Ancient Borough of Pontefract, and Some of its Recent Municipal Works.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates' and Students' Section) (Newcastle-upon-Tyne), at 2.30.—W. S. Armstrong: Bore-holes and their Purposes.—F. E. Smyth: Diamond Boring Applied to Tapping Drowned Areas Underground.—*Paper open for further discussion:*—The Use of Carbon-Monoxide Gas-Masks in Mines, R. White.

INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch) (at College of Technology, Manchester), at 7.—T. Makemson: The Prospects and Opportunities of Young Foundrymen (Presidential Address).

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES (Autumn Meeting).—Visits to Croydon Aerodrome and Air-Port, and to Whitgift's Hospital, Croydon.

MONDAY, OCTOBER 29.

CAMBRIDGE PHILOSOPHICAL SOCIETY (Annual General Meeting) (in Cavendish Laboratory), at 4.30.—Sir Ernest Rutherford: The Energy of Atomic Nuclei.—Dr. P. A. M. Dirac: The Basis of Statistical Quantum Mechanics.—P. M. S. Blackett: On the Design of a Camera for a Wilson Apparatus.—L. H. Gray: Theoretical Considerations Concerning Penetrating Radiation.—N. A. de Bruyne: Note on the Effect of Temperature on the Auto-electronic Discharge.—J. Hargreaves: The Dispersion Electrons of Lithium.—E. E. Watson: Current Measurement with a Compton Quadrant Electrometer.—*Papers to be communicated by title only:*—Dr. D. R. Hartree: The Propagation of Electromagnetic Waves in a Stratified Medium.—Dr. D. C. Rose: Some Experiments on the Multiple Scattering of Alpha Particles.—D. Burnett: Directional Properties of Wireless Receiving Aerials.—L. A. Pars: The Classification of Orbits.—J. R. Wilton: A Note on Ramanujan's Arithmetical Function $\tau(n)$.—Miss W. L. C. Sargent: On Young's Criteria for the Convergence of Fourier Series and their Conjugates.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—T. W. P. Lawrence: Demonstrations of Surgical Specimens.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—The President and others: Discussion on Our Profession from a Manufacturer's Point of View.

ILLUMINATING ENGINEERING SOCIETY (Manchester Section) (at Electric Lighting Service Bureau, Manchester), at 7.—J. L. H. Cooper: An Investigation of Electric Lighting in the Engineering Industry.

SOCIETY OF CHEMICAL INDUSTRY (Yorkshire Section) (at Great Northern Station Hotel), at 7.15.—W. Bain: Asbestos and its Industrial Application.

BRADFORD ENGINEERING SOCIETY (at Technical College, Bradford), at 7.30.—A. H. Gledhill: Time Recording and Costing.

TUESDAY, OCTOBER 30.

INSTITUTE OF ACTUARIES, at 5.—A. Levine: Presidential Address.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. H. L. Callendar: Co-aggregation *versus* Continuity in the Change of State from Liquid to Vapour (Tyndall Lectures) (I.).

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Midland Hotel, Manchester), at 7.—J. H. Williams: Chairman's Address.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—F. S. G. Hinings: Chairman's Address.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Demonstration by Colour Photographs, Ltd., of a New Colour Process.

ELECTRICAL ASSOCIATION FOR WOMEN (at E.L.M.A. Lighting Service Bureau, 15 Savoy Street, W.C.).—Miss Gladys Burlton: The Study of Personal Salesmanship—Demonstrating Electrical Apparatus.

WEDNESDAY, OCTOBER 31.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (at Town Hall, Accrington), at 11.30.—Informal discussion on Bricks and Brickmaking.

ILLUMINATING ENGINEERING SOCIETY (Newcastle Centre) (at North-East Coast Lighting Service Bureau, Newcastle-upon-Tyne), at 7.15.—J. L. H. Cooper: An Investigation of Electric Lighting in the Engineering Industry.

SOCIETY OF CHEMICAL INDUSTRY (Newcastle-upon-Tyne Section) (in Chemical Lecture Theatre, Armstrong College), at 7.30.—Prof. H. V. A. Briscoe: Recent Investigations of the Properties of Coke.

FARADAY SOCIETY (jointly with Electroplaters' and Depositors' Technical Society) (at Northampton Polytechnic Institute), at 8.15.—Discussion on:—The Causes and Prevention of Pitting in Electro-deposited Nickel, D. J. Macnaughtan and A. W. Hothersall; On the Effect of Colloids in the Electro-Deposition of Silver from Silver Nitrate Solutions, S. Wernick; The Hardness of Electro-deposited Nickel, D. J. Macnaughtan and A. W. Hothersall; Investigations on the Electro-Deposition of Silver, E. B. Sanigar.

THURSDAY, NOVEMBER 1.

ROYAL SOCIETY, at 4.30.—Prof. O. W. Richardson and F. C. Chalklin: The Soft X-Ray Levels of Iron, Cobalt, Nickel, and Copper.—Dr. A. Müller: A Further X-Ray Investigation of Long-Chain Compounds.—Dr. J. E. Lennard-Jones and B. M. Dent: The Change in the Lattice Spacing at a Crystal Boundary.—R. W. James and G. W. Brindley: A Quantitative Study of the Reflection of X-Rays by Sylvine.—*Papers to be read in title only:*—G. S. Mahajani: A Contribution to the Theory of Ferromagnetic Crystals.—E. B. Moullin: An Ampere Meter for Measuring Currents of very High Frequency.—S. Goldstein: The Influence of the Earth's Magnetic Field on Electric Transmission in the Upper Atmosphere.—Prof. S. R. Milner: The 'Action' of an Electromagnetic Field.—Prof. H. A. Wilson: Chemical Equilibrium in the Vapour of a Mixture of Paraffins and Unsaturated Hydrocarbons.—E. H. Gowan: The Effect of Ozone on the Temperature of the Upper Atmosphere.—G. I. Finch and J. C. Stimson: The Electrical Condition of Hot Surfaces during the Adsorption of Gases. Part II.—N. A. de Bruyne: The Action of Strong Electric Fields on the Current from a Thermionic Cathode.—H. Gregory and C. T. Archer: The Thermal Conductivities of Carbon Monoxide and Nitrous Oxide.—N. K. Adam and G. Jessop: The Structure of Thin Films. Part XII.—Prof. H. Levy and A. G. Forsdyke: The Steady Motion and Stability of a Helical Vortex.—R. J. Cornish: Flow in a Pipe of Rect-

angular Cross-Section.—Prof. J. C. McLennan and G. Greenwood: The Decomposition of Ammonia by High Speed Electrons.—Prof. J. C. McLennan and A. M. I. A. W. Durnford: The Zeeman Effect for the Spectrum of Tantalum.—Prof. J. C. McLennan, R. Ruedy, and E. Cohen: The Magnetic Susceptibility of Single Crystals of Zinc and Cadmium.—Prof. J. C. McLennan, R. Ruedy, and A. C. Burton: An Investigation of the Absorption Spectra of Water and Ice with reference to the Spectra of the Major Planets.—Prof. J. C. McLennan, H. C. H. Ireton, and E. W. Samson: On the Luminescence in Solid Nitrogen under Cathode Ray Bombardment.—Dr. A. T. Doodson: The Analysis and Prediction of Tidal Currents from Observations of Times of Slack Water.—Prof. C. V. Boys: Solid Dipleidoscope Prisms, Supplement.—Prof. J. S. Townsend: Motions of Electrons in Gases.—Dr. J. E. Lennard-Jones and H. J. Woods: The Distribution of Electrons in a Metal.—W. West, R. H. Müller, and E. Jette: Studies on Fluorescence and Photosensitisation. I. Introduction.—E. Jette and W. West: Studies on Fluorescence and Photosensitisation. II. Fluorescence in Aqueous Solution.—R. H. Müller: Studies on Fluorescence and Photosensitisation. III. Photosensitisation and Fluorescence.—Prof. W. A. Bone, L. Horton, and L. J. Tei: Researches on the Chemistry of Coal. V.—P. White and G. Millington: The Velocity Distribution of β-Particles after passing through Thin Foils.—Prof. C. G. Darwin: (*a*) On the Magnetic Moment of the Electron; (*b*) On the Diffraction of the Magnetic Electron.—P. C. Allen and C. N. Hinshelwood: The Catalytic Decomposition of Gaseous Acetaldehyde at the Surface of Various Metals.—R. Chaplin: The Sorption of Carbon Tetrachloride at Low Pressures by Activated Charcoals.—N. A. Alston and J. West: The Structure of Topaz.—H. J. Braddick and H. M. Cave: The Rate of Emission of Alpha Particles from Radium.—Prof. W. E. Curtis and A. Harvey: The Structure of the Band Spectrum of Helium. V.—Prof. W. A. Bone, D. T. A. Townend, and G. A. Scott: Gaseous Combustion at High Pressures. Part XI.—Prof. W. A. Bone, D. M. Newitt, and C. M. Smith: Gaseous Combustion at High Pressures. Part XII.—K. Krishnamurti: Investigations on the Scattering of Light in Colloidal Solutions and Gels. I. Agar Sol and Gel.—Dr. P. E. Shaw: Tribo-Electricity and Friction. IV. Electricity due to Air-blown Particles.—Prof. C. V. Raman and K. S. Krishnan: The Production of New Radiations by Light Scattering. Part I.—Prof. H. L. Callendar: Steam Tables and Equations extended by Direct Experiment to 4000 lb./sq. in. and 400° C.—W. R. C. Coode-Adams: The Refractive Index of Quartz.—R. C. Johnson: The Band Spectra of the Alkaline Earth Halides. I. CaF, SrF. II. BaF, MgF.—J. M. Walter and S. Barratt: The Band Spectra associated with Zinc, Cadmium, and Mercury.—Dr. W. Jevons: Observations in connexion with the Band Systems of the Fluorides of Beryllium and Magnesium.—G. Temple: The Scattering Power of a Bare Nucleus according to Wave Mechanics.—J. Topping: On the Form and Potential Energy of the Isomorphous Crystals, Ruby (Al_2O_3) and (Fe_2O_3).

LINNEAN SOCIETY OF LONDON, at 5.—V. S. Summerhayes: A Revision of the Australian Species of *Frankenia*.—Dr. Helene E. Bargmann: The Morphology of the Central Nervous System in the Gastropoda Pulmonata.—Miss T. L. Prankerd: Studies in the Geotropism of Pteridophyta. 4. On Specificity in Graviperception.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. A. G. Gibson: Pyelitis and Pyelonephritis (Bradshaw Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Capt. G. Pitt-Rivers: The Clash of Culture (I.). Race and Culture.

BIOCHEMICAL SOCIETY—UNIVERSITY OF BIRMINGHAM (at University of Birmingham), at 5.30.—F. E. Salt and H. B. Salt: Essential Oils and Perfumes.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (jointly with Electrical Association for Women) (at Municipal College, Birmingham), at 7.—Dr. S. Z. de Ferranti: Electricity in the Service of Man (Faraday Lecture).

ILLUMINATING ENGINEERING SOCIETY (Glasgow Centre) (at 25 Bath Street, Glasgow), at 7.30.—J. L. H. Cooper: An Investigation of Electric Lighting in the Engineering Industry.

SOCIETY OF CHEMICAL INDUSTRY (Bristol Section) (jointly with Chemical Engineering Group) (in Chemical Department, Bristol University), at 7.30.—W. F. Darke and E. Lewis: Glycerin and its Substitutes in Industry.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 7.45.—W. D. Douglas and Miss C. B. Pettifor: The Testing of Adhesives for Timber.

CHEMICAL SOCIETY, at 8.

INSTITUTION OF MECHANICAL ENGINEERS (Glasgow Branch) (at Glasgow).—Eng.-Comdr. J. B. Sidgwick and Dr. V. E. Pullin: Steel Castings.

INSTITUTION OF MECHANICAL ENGINEERS (Manchester Branch) (at Manchester).—A. B. Mallinson: An Up-to-date Cotton Mill Power Plant.

INSTITUTION OF MECHANICAL ENGINEERS (Leeds Branch: Graduates' Meeting) (at Leeds).—B. H. Thorp: Gaseous Explosions.

FRIDAY, NOVEMBER 2.

INSTITUTION OF ENGINEERING INSPECTION (at Royal Society of Arts), at 5.—A. H. Mundey: Die Casting.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: The Evolution of the Human Foot and its Bearing on Orthopædic Disorders of the Foot.

PHILOLOGICAL SOCIETY (at University College), at 5.30.—E. D. P. Evans: Wye Rivers.

BRITISH PSYCHOLOGICAL SOCIETY (Æsthetics Section) (at Bedford College), at 5.30.—Miss E. M. Bartlett: Some Types of Æsthetic Judgment.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Mining Institute, Newcastle-upon-Tyne), at 6.—E. G. Barrilon: From Theoretical Hydrodynamics to Practical Ship Design.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group, Informal Meeting), at 7.—Miss Agnes B. Warburg: Light and Space.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—Cinematograph Film showing the Principle, Construction, Erection, and Operation of the Babcock Boiler.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—Annual Conversazione.

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (jointly with Manchester Sections of Institute of Chemistry, Society of Dyers and Colourists, and Manchester Literary and Philosophical Society).—Sir John E. Russell: Application of Chemistry in Modern Farming.

SATURDAY, NOVEMBER 3.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Rev. T. E. R. Phillips: Recent Observations and Discoveries respecting the Planets (I.).

PUBLIC LECTURES.

SATURDAY, OCTOBER 27.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. Edith Durham: A Montenegrin Ballad of Old Tribal Life.

TUESDAY, OCTOBER 30.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Dr. A. T. Henderson: Studies in Asthma and Related Diseases. Clinical Studies—(*a*) Hay Fever, Seasonal and Perennial; (*b*) Skin Manifestations: Urticaria, Eczema, Angioneurotic Œdema, Ulceration of the Cornea; (*c*) Summary and Conclusions (Harben Lectures).

UNIVERSITY OF BRISTOL, at 5.30.—Sir J. H. Jeans: The Physics of the Universe (Henry Herbert Wills Memorial Lecture).

KING'S COLLEGE, at 5.30.—Sir Francis Younghusband: Philosophy, Science, and Religion.

GRESHAM COLLEGE (Basinghall Street), at 6.—W. H. Wagstaff: Geometry. (Further Lectures on Oct. 31, Nov. 1 and 2.)

UNIVERSITY OF BRISTOL (in Physiological Lecture Theatre), at 8.30.—Dr. J. O. Symes: The Relation of Erythema Nodosum to Tuberculosis and other Diseases (Long Fox Memorial Lecture).

WEDNESDAY, OCTOBER 31.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Dr. S. W. Fisher: Pains and Pleasures of a Miner's Life.

KING'S COLLEGE, at 5.30.—Prof. E. Wilson: Electrical Science and Industry.

THURSDAY, NOVEMBER 1.

ROYAL SOCIETY OF MEDICINE, at 5.—Prof. M. Hajek: Laryngo-Rhinology and General Medicine (Semon Lecture).

BEDFORD COLLEGE FOR WOMEN, at 5.15.—Miss U. M. Ellis-Fermor: The Poetry of Travel (Elizabethan Age).

FRIDAY, NOVEMBER 2.

UNIVERSITY COLLEGE, at 5.30.—Dr. J. S. Owens: Smoke Pollution of the Air and Public Health. (Further Lectures on Nov. 9 and 14.)

SATURDAY, NOVEMBER 3.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—F. W. Edwards: A Naturalist's Trip to the Southern Andes.

CONGRESSES.

OCTOBER 29, 30, 31, NOVEMBER 1.

INTERNATIONAL CONFERENCE ON LIGHT AND HEAT IN MEDICINE, SURGERY, AND PUBLIC HEALTH (at University of London, S.W.7).

Monday, Oct. 29.

3.30–5.—Dr. W. J. O'Donovan: Actinotherapy in Nervous Affections of the Skin.

Dr. F. Nagelschmidt: A New Method of Applying Heat by Diathemy.

7.30–9.—Dr. W. Flaskamp: Light and Heat in Gynæcology.

Dr. W. K. Russell: A Consideration of Apparatus for the Production of Ultra-violet Rays for Medical Purposes.

Tuesday, Oct. 30.

3.30–5.—Dr. C. B. Heald: The Development of New Electro-therapeutic Apparatus.

Dr. F. Nagelschmidt: Foam Treatment.

7.30–9.—Dr. M. J. Dorcas: Energy Distribution of Various Types of Arc Lamps.

Wednesday, Oct. 31.

3.30–5.—F. Talbot: Actinotherapy and Dental Caries.

Dr. A. J. Cemach: U-V Therapy in Oto-rhino-laryngology.

7.30–9.—Sir Henry Gauvain: Heliotherapy and Artificial Light Treatment in Surgical Tuberculosis (Film).

M. Weinbren: Ultra-violet Radiation in the Treatment of Chronic Pulmonary Tuberculosis.

Thursday, Nov. 1.

3.30–5.30.—Dr. A. Eidinow: Photosensitisation.

Dr. C. C. Morrell: Plant Pigments in Relation to Photosensitisation.

T. C. Angus: The Efficiency of Ultra-violet Light Producers.

NOVEMBER 3.

SOCIOLOGICAL SOCIETY, LEPLAY HOUSE, AND TOURS ASSOCIATION (at London Day Training College).

At 10.30 A.M.—Reports on the Work done during the past Year by Leplay House Sociological Society and Leplay House Tours Association.

At 11.15 A.M.—Social Studies in Majorca.—Miss M. Maplesden: Geology and Flora in Majorca.—G. Morris: Some Notes on Swedish Lapland.

At 2.30.—C. C. Fagg: Some Results of the Croydon Survey.

At 4.45.—A. Farquharson, and Group Leaders from the Tours Students' "Camp," 1928: Field Studies at St. Peter.