THURSDAY, JULY 24, 1919.

## A GUIDE TO LENS CALCULATIONS.

*Applied Optics: The Computation of Optical Systems.* Being the "Handbuch der angewandten Optik" of Dr. Adolph Steinheil and Dr. Ernest Voit. Translated and edited by James Weir French. Vol. ii. Pp. vi+207+v plates. (London: Blackie and Son, Ltd., 1919.) Price 12*s*. 6*d*. net.

THE introductory section of this volume [1] contains an explanation of the symbols employed and of the sign conventions adopted, together with extensive tables of formulæ designed to cover the trigonometrical calculation of rays through a series of centred refracting surfaces. The system described is probably far more extensively employed than any other by practical opticians. It is constructed throughout with a view to convenience in logarithmic computation, and only minor improvements have been effected since it was first published. Its popularity has not been seriously affected by the introduction of the calculating machine into the workshop.

After a chapter on the measurement of refractive indices and the calculation of achromatic prisms come three chapters on achromatic doublet objectives, which include fully worked examples of the application of the formulæ given earlier. The authors set out to record their experience in designing optical systems, and to this end have tabulated the results obtained with series of objectives corrected for spherical and chromatic aberrations. They have not indicated which zone of the objectives should be corrected to yield the most satisfactory performance, nor the maximum amount of the aberrations present for uncorrected zones, but, owing to the care with which the objectives have been calculated, the results given are of sufficient value to ensure for the book a place on the reference shelf of the optical computer. In finding the forms for the lenses the authors have been guided by a number of principles derived from the calculation of rays through a series of single lenses (see vol. i.). Of these, that relating to the influence of the lens form on spherical aberration may be singled out as of paramount importance in designing doublet objectives. The principle states that the spherical aberration of a single lens is a minimum when the deviation of a ray is divided equally between the two surfaces, and subsequent developments show that this is regarded as an exact law rather than as a rough approximation. This conclusion is decidedly surprising, as the spherical aberration has previously been found to be less when the deviation is divided in the ratio 3 : 2 than when it is equally divided. It is not difficult to prove that, for minimum aberration, the deviation at the first surface must be greater or less than that at the second according as the dimensions of the object are greater or less than those of the image. The extent of the difference involves the refractive index as well as the magnification, and cases may easily arise in which the supposed law leads to serious errors. The forms given for the lenses with flattest possible flint components are incorrect, owing to this error of principle.

It may be noted that some conclusions which were correct at the time the book was written do not necessarily apply if types of glass produced within the last thirty years are employed.

The original German edition was not free from a number of important errors, and most of these are present in this translation. In a second edition the formulæ should be carefully revised, and errors in the constructional data of the objectives corrected by recalculation. The original text is not always adhered to, and the new definition for the sign of the deviation gives the wrong result for a ray below the axis. The awkward ± sign, which occurred frequently in the original, has generally been avoided. Changes have been made in the symbols, but $\pi$ is retained as a variable angle. The table of differences between arcs and sines, intended for use in removing small residuals of spherical aberration, has been omitted. The appendices by Steinheil and Seidel on the determination of the best mean dispersion ratio, and by Seidel on the derivation of the formulæ for tracing a general ray, have been included in this volume.

The translator has written a clear English text. The book is very well printed, and the thickness of the paper will be appreciated by those who require to refer to it frequently. One of the most serious omissions of the original has been remedied by the inclusion of a very complete index. No pains have been spared to make the volume worthy of the position it is intended to take as a standard book of reference for the optical computer.

T. S.

[1] A review of the first volume was published in NATURE, September 26, 1918, vol. cii., p. 61.

## COLLOID-CHEMISTRY.

*A Handbook of Colloid-Chemistry. The Recognition of Colloids, the Theory of Colloids, and their General Physico-Chemical Properties.* By Dr. Wolfgang Ostwald. Second English edition, translated from the third German edition by Prof. Martin H. Fischer. With numerous notes added by Emil Hatschek. Pp. xvi+284. (London: J. and A. Churchill, 1919.) Price 15*s*. net.

THE increasing recognition of the importance of a study of colloidal matter, both for physical theory and for industrial practice, has led to a growing demand for text-books dealing specially with this branch of science. Hitherto this demand has been chiefly met by works in the German language or by translations of these, and of such works the one before us has for a number of years occupied a foremost place. This, doubtless, is due in no small measure to the marked activity of the author both as an investigator and as editor of the *Kolloid-Zeitschrift.* Wolfgang Ostwald possesses in no small degree the literary facility of his father; and although this facility leads sometimes to an over-wordiness of expression, the author has had considerable success in directing the attention of wide circles of workers to the importance of the study of colloids.

Although the third German edition, from which the first English translation was made, was published in 1912, the translation was not published until 1915. It will be understood, therefore, that the publishers and translator were placed in a position of some difficulty when they had to meet the demand for a new edition of the English version of the work. To issue merely a reprint would have meant the continuance for some years of a book which at the time of its first appearance was already somewhat out of date; and to obtain a revision of the book by the author was impossible owing to the existence of a state of war. A compromise was therefore adopted, the co-operation of Mr. E. Hatschek was obtained, and an attempt was made to revise and bring up to date the original translation. The translators have sought to meet the situation "by leaving entirely untouched those large portions of the volume which contain the author's individual views, to correct errors in quotation and in mathematical formulæ, and to add" (by the pen of Mr. Hatschek) "numerous paragraphs intended to bring to the reader various important advances in colloid-chemistry which have been made since 1912, especially such as have to do with the mechanical properties of colloids, more particularly their viscosity." The reviewer must confess that he is not impressed by the success of the attempted revision.

It is to be regretted, in the first place, that the translators have not indicated more clearly the additions which have been made, but it would appear, from such comparison with the first edition as the reviewer has been able to carry out, that the additions are confined, essentially, to two sections on "Rate of Shear and Viscosity of Emulsoids" and "Theory of Viscosity of Emulsoids." These two sections, by an active worker in this domain, are valuable and have been satisfactorily incorporated in the work. Sentences have also been added here and there, but the book, as a whole, can scarcely claim to be up to date; and it is to be regretted that the translators did not seek more fully a way out of their difficulties by more numerous footnote references to the recent literature. Apart from those in the new sections added by Mr. Hatschek, the reviewer has noticed only about half a dozen references to literature published since the date of the first edition. The translation has, in several particulars, been improved. "Dispersion medium," for example, has been substituted for "dispersion means," but it seems a pity to retain the expression "internal friction" for "viscosity," and a still greater pity to make use of both terms in a somewhat haphazard manner. "Molecular kinetic" could, with advantage, be everywhere substituted for "moleculo-kinetic," and experimental "results" would be more pleasing, to an English ear at least, than experimental "findings."

Apart from the criticism which has been offered, the book is a very useful one both for the specialist student of colloids and for the large number of workers in the various domains of science and industry in which colloids are now recognised as playing an important part. A survey of the more important features of colloid-chemistry is here presented in an interesting and readable, although sometimes rather too diffuse, form; and the book furnishes a good introduction to a more detailed and special study of the subject. The work does not, however, claim to be exhaustive, and the translators, by rendering "Grundriss" as "Handbook," give a somewhat false idea of the scope of the book.

A. F.

## *PHYSIOLOGY FOR STUDENTS AND PRACTITIONERS.*

*A Text-book of Physiology.* By Dr. Martin Flack and Dr. Leonard Hill. Pp. viii+800. (London: Edward Arnold, 1919.) Price 25*s*. net.

THE authors of this text-book deserve hearty congratulations on having treated the subject in a somewhat unorthodox way which is decidedly interesting. Whether the work will appeal to the rather whimsical tastes of the medical student or teacher remains to be seen, since, on one hand, it may be regarded as departing, in certain respects, too much from the beaten track of examination requirements, and, on the other, cannot by any means be regarded as a cram-book for rapid revision. It is, nevertheless, written expressly for the use of medical students and practitioners, to the latter of whom it should appeal strongly.

The authors, as teachers of long experience and wide repute, have a right to record their general attitude to the subject in the form of a text-book, but it is almost certain that many teachers will disagree with them regarding the balance of the various sections of the work. Among the best features of the book are the clearness of the tables and schemes, and the great wealth of illustrative detail drawn from the most varied sources (pp. 500, 633, 771, for instance). The chemical parts are treated with brevity, and contain some statements that will not be generally accepted. Thus (p. 31) colloids are said to exert no osmotic pressure; again (p. 85), it is questioned whether amino-acids are normal constituents of blood plasma; on p. 93 the chemistry of formation of methæmoglobin is unorthodox.

One of the most fully treated sections is that dealing with the circulation; there are, however, some errors in this portion—for instance, in the description of the heart-lung preparation and in the account of the cardiometer (Fig. 68); it is also unfortunate that reference is not made to the term "premature contraction" as an alternative to "extra systole," as the latter is objected to by some authorities. These small points are chosen as illustrating the kind of thing which can be readily altered in subsequent editions. The question of the general balance of the book is largely a matter of opinion, and probably no two readers will agree as to the chapters which might be considered as inadequately treated; to the present reviewer those on the central nervous system, the kidney, and the physiology of muscle and nerve appear to require expansion. Histological considerations are omitted, no doubt in order to save space, but, nevertheless, there are a large number of illustrations; some of these (52, 53, 336, 391–393, 399, 400) might perhaps have been omitted without much loss, though the excellence of the illustrations is one of the strong features of the book; few of them are likely to be familiar to students from perusal of other text-books.

The book should be much appreciated by advanced students on account of the treatment of some of the sections in a manner new to students' books, and by elementary students owing to the interesting manner in which the subject is treated.

## OUR BOOKSHELF.

*Biochemical Catalysts in Life and Industry. Proteolytic Enzymes.* By Prof. Jean Effront. Translated by Prof. Samuel C. Prescott, assisted by Charles S. Venable. Pp. xi+752. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1917.) Price 23*s.* net.

THE name "biochemical catalysts" is used by the author as an alternative for the more usual name of "enzymes," and has the advantage of calling to mind the fact that these are only a particular class of catalysts. The present work is devoted to those enzymes which act on proteins and their degradation products. It includes also a discussion of the phenomena of immunity, as well as of the processes of coagulation of the blood and milk, processes with regard to which some doubt may be felt as to their being catalytic. Urease is also described.

An excellent and complete account of the subject is given up to the date of the original French work, which appears to be not later than 1912. It is somewhat unfortunate that the translator has not added supplementary notes to bring the book up to date, an addition that would have much increased its value. Indeed, some may be inclined to wonder why the mere translation of the original book was considered necessary. All readers interested should be able to read the French edition. The date of the original work doubtless accounts for some statements which are no longer correct. For example, it is said that enzymes are proteins, and the existence of true anti-bodies to enzymes is accepted. In this connection it may be mentioned that British and American work is rather meagrely referred to. On the whole, however, the book will be found a useful one, especially in that part dealing with those industrial processes in which proteolytic enzymes play an important part. Such are brewing, cheese- and bread-making, tanning, and their use in therapeutics. The fixation of nitrogen by the soil and the question of the value of amino-acids as exclusive nitrogen food for animals are discussed in some detail.

An interesting introductory section will be found. We may note that the author is inclined to favour the theory of surface action rather than that of the formation of intermediate compounds of a chemical nature. W. M. B.

*Formulaire de l'Electricien et du Mécanicien.* By Hospitalier et Roux. Vingt-neuvième édition (1919). By Gaston Roux. Pp. 11+1485. (Paris: Masson et Cie, 1919.) Price 20 francs.

THE older generation of electricians are well acquainted with the earlier editions of this work; and much of our standard nomenclature, as well as many of the symbols in everyday use, is due to Hospitalier. Nowadays numerous other pocket-books partially fulfil the functions of a book of reference for electricians, but not any of them are so complete or so well arranged as this book. We are inclined to grumble at its size—it contains now nearly 1500 pages—but it is difficult to find anything that might be cut out with advantage, and there are many subjects, like wireless telegraphy and telephony, which one would like to see included.

The first 500 pages are on purely academic subjects—mathematics, physics, dynamics, etc. —and enable the engineer to refresh his memory of his college studies. The next 600 pages are on electro-technical subjects, and the remainder of the book contains French official documents, a comparison of which with our own Board of Trade regulations is very instructive. A complete index is given.

In several places theorems have been abbreviated in order to save space, with unfortunate results. For instance, the theorems on the design of networks are almost unintelligible. On p. 856 we cannot understand what Santarelli's theorem is. In the first theorem by Bochet there is a fairly obvious misprint in the final formula. In the second it is not stated what condition the conductors have to fulfil in order that their mass may be a minimum; the formulæ given, therefore, may well be misleading. From the 1909 edition we find that the condition they must satisfy is that the sum of the voltage drops is constant. This is quite unpractical. The real condition is that the power expended in them should be a minimum when the maximum voltage drop is fixed. The solution of this problem does not agree with that given on p. 857. A. R.

## LETTERS TO THE EDITOR.

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

### Research and Service.

THERE appeared in NATURE for February 13 last a criticism from the pen of Prof. F. Soddy of an attitude expressed by me in my book entitled "The Twin Ideals." As there seems to be some possibility of misunderstanding, owing to the form of the work, may I briefly express the position I endeavoured to indicate? Those who indulge in the monastic attitude, who withdraw from the world and prosecute research of a recondite character, are outside reasonable criticism provided the work is done at their own expense. If, however, this work is to be supported from public funds, justification is necessary, and the justification has appeared to me to be twofold. In the first place, few people have the inclination or capacity for research, and it is therefore an attitude that should be encouraged. In the second place, practical discoveries of value are at times made incidentally to research of the kind. It appears to me, however, that much damage is done by the assumption on the part of such researchers that their efforts are the only line of research worth considering. I have never been able to satisfy myself that research conducted with a definitely practical end in view would not be equal to, if not more valuable than, the monastic form. I have, therefore, simply asked that in their attitude to the world at large those who prefer the life of the scientific recluse should recognise the equal value of the work of those whose inclinations take them in a practical direction, and that they should not seek to divert bright young intelligences into their own channel of activities when they tend to develop in the opposite direction.

Furthermore, there seems to me to be a moral obligation on all men of science to take practical steps for the diffusion of the knowledge gained, so that anything of practical value may be utilised by humanity in general. It has seemed to me that the monastic habit in researchers, together with indifference to the immediate requirements of the world and with the disposition to regard their own set of activities as paramount, is apt to produce results that are beneficial neither to the individuals concerned nor to the nation. JAMES W. BARRETT.

SIR JAMES BARRETT reiterates in his letter the views he has expressed in his book "The Twin Ideals," which I reviewed in NATURE, but I fail to see how they have been or can be misunderstood. He says that at times practical discoveries of value are made incidentally to researches pursued for their own sake, apart from practical ends, and that such investigators assume their efforts to be the only kind of research worth considering. It would be more generally agreed, I think, that all the great practical advances of the present scientific era owe their origin to purely theoretical investigations pursued for their own sake, and that such work is as different from the pursuit of practical discoveries of value as scientific exploration is from prospecting for gold, minerals, or specific commodities. To ask whether researches conducted with a definite practical end are not equal, if not superior, to those concerned with the advancement of the boundaries of knowledge seems like asking whether the fruit of a tree is not of equal or superior value to its root. To suggest that those pursuing researches of a recondite and academic character, who find it necessary for their work to withdraw largely from the practical world of affairs and politics, are only outside reasonable criticism if their work is pursued at their own expense seems as unreasonable as to deny nourishment to the roots of a tree because of their recluseness, their indifference to the immediate requirements of the world and inability to survive being hauled out into it. FREDERICK SODDY.

### Wild Birds and Distasteful Insect Larvæ.

IN the literature on mimicry and protective colouring, many writers have claimed that both the larva and imago of the currant moth (*Abraxas grossulariata*, Steph.) are protected by colouring and an acrid flavour, in consequence of which they are usually rejected by wild birds. That the larvæ of certain moths are distasteful to birds has been proved by actual experiment, but I have considerable doubts as to the inclusion of the currant moth in this category.

In my work on the food of wild birds I have found the imagines, and more often the larvæ, of Abraxas in the stomach of the song thrush, missel thrush, blackbird, great tit, whitethroat, house sparrow, yellow bunting, and cuckoo; and in 1918 large numbers of the larvæ were found in the stomachs of the song thrush and missel thrush over a period of seven consecutive days.

In the case of the song thrush, the parent birds were observed collecting these larvæ during the first five or six days after the young were hatched, and were seen to bring the same to the nest, where they were readily devoured by the young birds. Indeed, a very large proportion of the food fed to the nestlings during this period consisted of the larvæ of Abraxas. Then the parent birds suddenly ceased to feed upon them.

Knowing that the supply was by no means exhausted, the currant bushes were examined and numerous larvæ observed. Forty-one specimens were collected and placed on fresh leaves in large glass dishes, but not one of the larvæ reached the pupa stage. From this collection we hatched out fourteen masses of cocoons of Microgaster and twenty-seven specimens of Exorista.

Although the currant bushes were very badly infested with the larvæ, we failed to find any pupæ in the soil beneath them, although it was collected and most carefully searched; moreover, during the present season not a single larva of Abraxas has been found on these bushes, and there must have been thousands of them during 1918.

Here, I think, we have an explanation of why the thrushes ceased to feed upon the larvæ, viz. because they were parasitised, and also an excellent example of two natural agencies—wild birds and insect parasites—practically exterminating what would undoubtedly have been a plague this year.

It is well known that the larvæ of Abraxas are frequently parasitised by the two above-mentioned insects. Is it not possible that the parasitised larvæ alone are rejected by wild birds, and only the non-parasitised specimens fed from?

WALTER E. COLLINGE.

The University, St. Andrews.

### Science and Salaries.

THE issue of NATURE for July 11 contains a large number of advertisements of vacant posts of which details as to salary are stated in seventy-five cases. A few advertisements, which have been omitted from the following calculation, made no mention of salary.

Of the seventy-five, some said nothing about annual increment, a few gave the initial salary only, several gave both initial and maximum salaries, and some sufficient data to find the true average value of the salary over a number of years. This information has been used to deduce reasonable estimates of the prospects of advancement in other cases where the full data were wanting.

The posts were classified into three divisions, which comprised, roughly, (A) professorships, (B) lectureships, and (C) demonstratorships, or the equivalent of these, though of necessity a certain amount of discretion was used in the process. The average of the mean (not the minimum) salary in each class was then found, with the following result:—

| Class | Number of vacancies | Average of mean salary £ |
|---|---|---|
| A | 16 | 620 |
| B | 22 | 385 |
| C | 37 | 234 |

The posts of the first class were nearly all at fixed salaries; those of the second started at, roughly, 320*l.*, rising to 450*l.*, per annum; those of the third went from an initial salary of about 200*l.* to 270*l.* These salaries probably give a fair idea of the value placed by governing bodies on the trained brain at the present day. They are undoubtedly higher than would have been the case in pre-war conditions, at least in the lower and middle of the two classes; but if the best brain-power of the nation is to receive full encouragement—and if labour difficulties are to disappear, production increase, and British civilisation advance, this can come only from full encouragement—these salaries are still far from adequate. Money has to-day little, if any, more than 45 per cent. of its purchasing power previous to the war. Salaries of 200*l.* and 600*l.* to-day bring their possessors no greater shares of economic goods than 90*l.* and 270*l.* in 1914.

It is beginning to be recognised—it is already recognised in the United States—that the elevation of the general level of prices is now more or less permanent, and that a return to a lower level, at least in this generation, is improbable, even if it should be desirable. The class of manual labourers has had its wages increased almost, if not quite, in proportion to the rise in prices. The mercantile community, working as it does on percentage margins, has made ordinary profits commensurate with that rise, and, in addition, has obtained unearned profits resulting from the rise itself. The class of fixed salary earners, which comprises the brain-workers of the nation, the professional class, has borne the brunt of the rising prices without anything like an adjustment of salary corresponding with the rise. It is the hardest hit of all by the war, and yet this class, perhaps more than any other, has contributed to winning the war. Hitherto patriotism has kept it silent. Now, however, the time has come when the scale of the professional man's salary must be revised. Incomes such as those found above do not admit of the upbringing and education of a family as befits its inherited ability; of the expenses inevitable if a man is to keep abreast of his profession; and of saving and insurance against sickness, age, and death.

"In war-time," writes the *Economist* of July 12, in a "business note" on British and German science, "we make full use of our men of science. If we did so in peace they might be as useful for production as they have been for destruction." The first step is to see that they get what, for them, is a living salary, else there will be no men of science to use. The second step is to see that their teachers get adequate remuneration, else there will be no training to make men of science of them. C.

## *MODERN SINGLE-OBSERVER RANGE-FINDERS.*

THIRTY years ago the War Office asked for a rangefinder for field service that would measure ranges to within 4 per cent. at 1000 yards—that is, 40 yards at 1000 yards, or 160 yards at 2000 yards. A single-observer rangefinder of 30 in. base was designed to fulfil these requirements. In 1892 a naval rangefinder was required that would work within an error of 3 per cent. at 3000 yards, which is equivalent to 1 per cent. at 1000 yards. This demand was met by a rangefinder of 4 ft. 6 in. base. Whereas in 1895 the effective range of naval gunnery was between 2000 and 3000 yards, the effective range in 1904 was 6000 yards. For this service a rangefinder of 9 ft. base was introduced.

At the Battle of Jutland in 1916, firing commenced at a range of more than 20,000 yards, and although the makers had already constructed rangefinders of 15 ft. to 35 ft. base, the majority of the Service rangefinders were still of 9 ft. base, the Fifth Battle Squadron alone having been equipped with 15 ft. base rangefinders capable of measuring a range of 20,000 yards to within 170 yards, an error equivalent to 18 in. at 1000 yards. The 30 ft. base rangefinders exhibited by Messrs. Barr and Stroud, Ltd., at their stand at the British Scientific Products Exhibition are designed to work within half this error (Fig. 1).

Thus in the development of single-observer rangefinders during the past thirty years, the uncertainty of observation has been reduced from 40 yards at 1000 yards to the equivalent of 9 in. at 1000 yards; that is, the accuracy has been increased 160-fold.

This increase of accuracy has been obtained by increasing the base length about 12-fold and the magnification about 3-fold, thus accounting for a 36-fold increase. The remainder of the increase has been attained by refinements in the design and construction of the optical and mechanical elements based upon the results of research work conducted continuously during many years by a large staff of scientifically trained observers.

The accuracy of observation when using a coincidence rangefinder is ultimately dependent upon the accuracy with which the eye can detect a want of alignment between the partial images of the object in the field of view, and this largely depends upon the manner in which the images are presented for observation. As a result of much experience and many experiments on the alignment of images as presented in the Barr and Stroud rangefinders, it would appear that, under ordinary good conditions of observation, a want of alignment between the images can be detected when they subtend at the eye an angle of about 12 secs., *i.e.* 0·0000582 in circular measure, although frequently a much smaller angle can be resolved.

If B is the base of the rangefinder, M the magnifying power, and R the range, then

$$\delta R = 0{\cdot}0000582\, R^2/MB.$$

From this formula it will be seen that, to decrease the error $\delta R$ at a particular range, either the magnification M or the base length B must be increased. In practice the magnification is limited by the permissible size of the optical parts and the necessity to provide for range-taking in dull light, by the quality of the optical glass, and by external circumstances such as mirage due to the intervening atmosphere. At the present time a magnification of more than 30 diameters is not desirable. When this maximum magnification is provided, the required accuracy of observation is then obtained by increasing the base length.

At the commencement of the war no British battleship carried a rangefinder of greater base than 9 ft. This base had been decided upon in 1904, when the maximum effective range for the opening of fire was generally assumed to be not greater than about 6000 yards. In the Battle of Jutland fire was carried out at ranges above 20,000 yards. The *Iron Duke,* which carried only 9 ft. rangefinders, opened fire at 12,000 yards. The rangefinders were, therefore, called upon to perform a duty at least four times as onerous as that for which they were originally designed. It will be understood that the substitution on existing ships of the larger types of rangefinders available involved extensive structural alterations that could not readily be carried out, and it is only within very recent years that the importance of rangefinding has been recognised as being sufficient to justify the ships being designed for the accommodation of rangefinders most suitable for the guns.

Notwithstanding the use of 9 ft. rangefinders in association with guns, the power of which has been so greatly developed during the last twelve years, the British Fleet at the Battle of Jutland defeated the German ships, which there is good reason to believe were equipped with rangefinders of 20 ft. base and, probably, to some extent 33 ft. base. In such circumstances it is not surprising that the German rangefinding was excellent: it is more surprising that it was not very much better and that its excellence was confined to the first stage of the action.

It should be observed that, for a given gun, the longer the range the more necessary it is to know the range accurately, on account of the greater angle of descent of the projectile—that is to say, an error of 100 yards in range has a much greater effect on the percentage of hits at 24,000 yards than at 6000 yards—but a rangefinder gives errors varying according to the square of the distance. The problem of finding a range of 24,000 yards within 100 yards is sixteen times as difficult as the finding of a range of 6000 yards within the same limit.

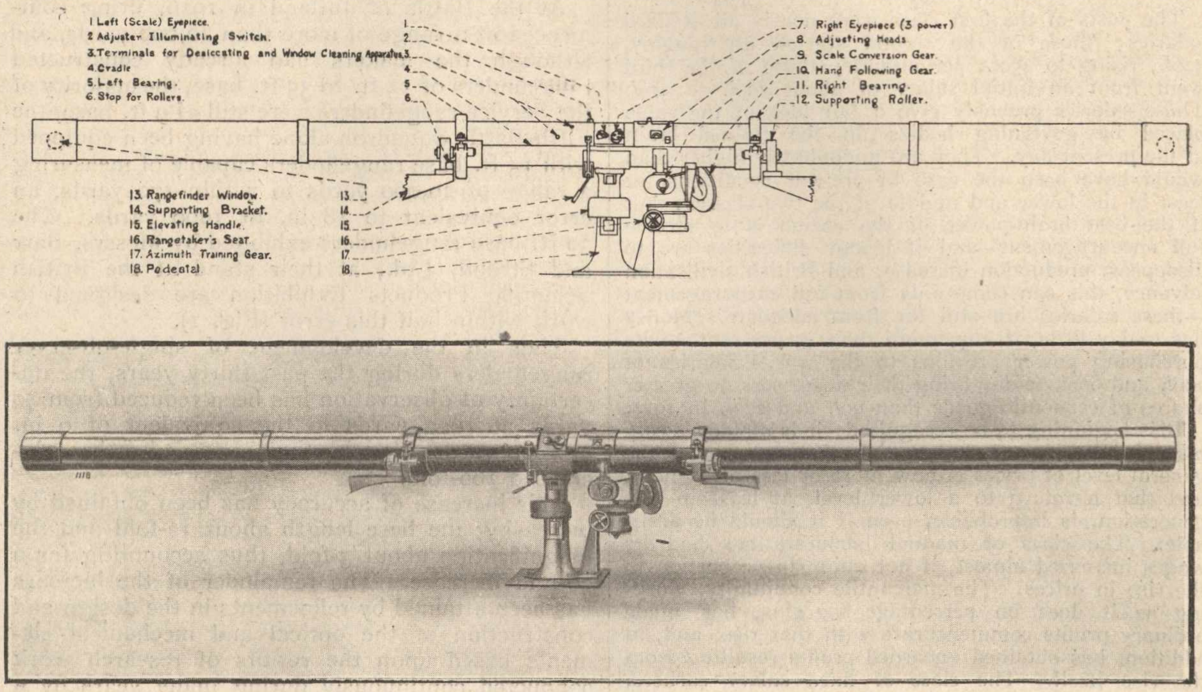


FIG. 1.—Naval rangefinder type F.X. with uniform range scale accessories. Base length 30 ft.; Magnifications 16, 20, and 28; uncertainty of observation under good conditions 330 yards at 40,000 yards range.

The modern rangefinder differs from the earlier types in the size of the optical parts and, consequently, of the mechanical parts, and in the provision of internal adjusting devices and of such accessories as variable power eye-pieces, light-filters, and apparatus involving complicated conical gearing for the conversion of the reciprocal scale into a uniform scale of ranges. Considerable improvements have been effected in the mountings, which are necessarily designed to suit particular requirements and the structural arrangements of the ships. Provision is now generally made for three operators, namely, the rangetaker, who also controls the rangefinder in elevation; the trainer, who is provided with a special sighting periscope; and the scale reader, who transmits the ranges to the fire control station.

The advent of aerial craft has necessitated the use of special combined range and height finders which automatically determine the height of the target from its range and elevation. In the case of naval anti-aircraft instruments, the vertical from which the elevation is reckoned is defined by means of a damped pendulum device. Anti-aircraft height finders for land purposes have the advantage of a steady platform, and in some respects the problem is simpler, as the horizontal can then be determined with sufficient accuracy by means of a good spirit level provided upon the mounting.

Whereas the range of an approaching aeroplane changes so rapidly as to make the operation of maintaining the coincidence of the partial images in the field of view of a rangefinder a matter of some difficulty, the height of the aeroplane remains comparatively constant for considerable periods. It is generally more convenient, therefore, to measure the height, from which the setting of the gun can be readily adjusted in relation to a suitably engraved gunsight scale. As the range is a function of the elevation when the height is constant, an arrangement has been devised whereby the partial images of the moving aerial target are kept in coincidence by the simple operation of following the target. For this purpose, the elevating gear is arranged to act upon the deflecting prism of the rangefinder through the intermediary of conical spiral gears, which are equivalent to cams of the requisite form. If the height alters, the partial images can be brought again into coincidence by independent direct operation of the working head. Both heights and ranges are indicated by the instrument, the latter being better suited to gunnery purposes when the aircraft appears at a long distance over the horizon.

The problem of hitting enemy aircraft at long ranges is greatly complicated by the necessity of taking account not only of the interval that must elapse between the finding of the range (or height) and the setting of this upon the gun-sights and the laying of the guns, but also of the greater interval between the time of firing of the gun and the arrival of the shot at its destination. The gun has to be sighted and laid, not for the ascertained position of the target, but for the position that it may be expected to occupy after an interval, it may be of thirty seconds or more, during which time the target may have travelled 1000 or even 2000 yards from the position that had been determined. The new and difficult problems thereby involved have already been solved, more or less completely, by the invention of predicting instruments closely associated with the range and height finders.

JAMES WEIR FRENCH.

## THE BOURNEMOUTH MEETING OF THE BRITISH ASSOCIATION.

THE eighty-seventh meeting of the British Association for the Advancement of Science will this year be held at Bournemouth, under the presidency of the Hon. Sir Charles A. Parsons, K.C.B., F.R.S., on September 9–13. The last meeting was held at Newcastle-upon-Tyne in 1916, the 1917 and 1918 assemblies having been abandoned owing to obstacles brought about by the war. This was the first break in the annual meetings of the Association since its inception in 1831. With the return of peace and happier conditions, it is anticipated that the Bournemouth meeting will be a successful and memorable one.

A strong local executive committee, with the Mayor as chairman, has been energetically at work for some months. The preliminary arrangements are well advanced, and every effort is being made to ensure the complete success of the meeting. So far as organisation is concerned, nothing is likely to be lacking, and it only remains for those interested or engaged in scientific work to take full advantage of the opportunities offered to them. Already the number of applications for election as annual members and associates is considerable, and doubtless as the date of the meeting approaches it will increase rapidly.

The Association will find a home in the Municipal College, a fine building, centrally situated, which was erected shortly before the war. Practically the whole of the college rooms will be placed at the disposal of the Association for the week, and will afford ample and conveniently centralised accommodation for its many and varied activities. Only the large public assemblies—the inaugural general meeting, at which the president's address is delivered; the discourses by Sir Arthur Evans, F.R.S., and Mr. Sidney G. Brown, F.R.S.; and the usual conversazione—will be held elsewhere. The Winter Gardens Pavilion, which is capable of seating an audience of upwards of 1200, will be the scene of these functions.

The programme of work is very full, and the week will be one of great activity. For the serious worker there will, as always, be many interesting papers and discussions, while the rumour that hitherto carefully guarded secrets of the work of men of science in the war will be made known for the first time is sufficient to appeal to the imagination of the general public and to focus attention upon the meeting.

Social functions will not form a marked feature of this meeting. The only official entertainment on a large scale will be the conversazione at the Winter Gardens on September 10. But Bournemouth is widely famous for its manifold attractions, and members and associates will have no difficulty in finding numberless opportunities for relaxation and amusement in their leisure hours.

In a popular seaside resort in September the pressure on the available accommodation will probably be great. Those attending the meeting are therefore advised to make their hotel or lodging arrangements without delay. The local executive committee is doing everything in its power to help them in this direction, and inquiries addressed to the Local Secretaries, Municipal Buildings, Bournemouth, will bring prompt and full information on the subject.

## NOTES.

THE visit of the King and Queen to the British Scientific Products Exhibition at the Central Hall, Westminster, on Tuesday, is a mark of Royal approval which will be highly appreciated, not only by the British Science Guild, which is responsible for the enterprise, but also by all who are working for the advancement of science and the extension of its industrial applications. Their Majesties, who were accompanied by Princess Mary and Prince Henry, were received by the Marquess of Crewe, president of the exhibition, and several members of the organising committee. They remained in the exhibition for about an hour and a half, and took the keenest interest in numerous machines, instruments, and products displayed, particularly in the exhibits of optical and laboratory glass and instruments, dyes and fine chemicals, radium, high-speed telegraphic printing, magnetos, Hadfield steels, potash salts from blast-furnace dust, seed-testing, and fruit and vegetable preserving. Both the King and Queen expressed much satisfaction that so many objects in the exhibition represented things formerly obtained chiefly or entirely from abroad, and congratulated the organisers of the exhibition upon the educational and practical value of this display of British productions. Their visit was a most encouraging sign of Royal concern for national activities which receive little official or public attention, though they are of prime importance; and it will doubtless induce many people to see for themselves what is really a stimulating display of scientific and industrial achievement.

A FUND is being raised in the medical profession to present Sir Clifford Allbutt with his portrait. Sir Clifford Allbutt has been, above all things, a great clinical teacher, first in Leeds and, after his appointment to be Regius professor of physic in 1892, in Cambridge. He was one of the first to show the value of the ophthalmoscope in the diagnosis of diseases of the nervous system, the kidney, and certain other general disorders; his volume on this subject was published in 1871. During the years 1896–99 he edited a great "System of Medicine," which had a success so immediate that a second edition was almost at once demanded. In the preparation of this, which appeared at intervals from 1905 to 1910, he was associated with Sir Humphry Rolleston. Sir Clifford Allbutt was elected president of the British Medical Association in July, 1914, and has retained that position throughout the war. The council of the British Medical Association, therefore, has taken the lead in asking for subscriptions to the fund to present Sir Clifford Allbutt with his portrait, to be painted by an eminent artist. From the portrait it is intended to commission a mezzotint engraving, which subscribers to the fund will be able to purchase for their own collections. Subscriptions, which are limited to one guinea, should be made payable to the "Sir Clifford Allbutt Presentation Fund," crossed London County, Westminster, and Parr's Bank, and addressed to the Treasurer of the British Medical Association, 429 Strand, London, W.C.2. A large number of subscriptions have already been received, and it is proposed to close the fund at the end of this month.

THE council of the British Association recently instructed a deputation, consisting of Prof. Arthur Keith, Sir Edward Brabrook, and Prof. A. W. Kirkaldy, to wait upon the Ministry of Pensions in order to urge the utilisation of anthropometric and kindred data collected by the disbanded Ministry of National Service. The deputation was received on behalf of the Minister of Pensions by Col. Arthur L. A. Webb, Director-General of Medical Services, Ministry of Pensions, who explained that the medical statistical department of the Ministry of National Service, of which Dr. H. W. Kaye was in charge, and the data collected by that department, had been taken over by the Ministry of Pensions. Under the Ministry of Pensions Dr. Kaye had not only to direct the compilation of medical recruiting statistics, but also to organise a special branch to deal with medical data connected with the Ministry of Pensions. It was thus impossible for Dr. Kaye's department to give its undivided attention to the preparation of returns relating to the physique of recruits in the various areas and trades of the country. At the present time all the data relating to Grade IV. men were being examined and compiled. Col. Webb also explained that Dr. Kaye's department was endeavouring to obtain data for comparison from Canada, New Zealand, and the United States. The deputation, before withdrawing, thanked Col. Webb, and urged the early publication of results, which are now needed by all who are studying problems connected with the present physical condition of our population.

THE council of the Institution of Electrical Engineers has issued a pamphlet on the Electricity (Supply) Bill, 1919, now before a Committee of the House of Commons. It is pointed out that great injury to the national interest has resulted from ill-considered electrical legislation in the past, and naturally electricians are anxious about the future. The appointment of Electricity Commissioners is welcomed provided that these Commissioners give whole-time service and appoint an Advisory Council, membership of which is restricted to persons possessing expert qualifications. The proposal that the Commissioners undertake and promote research also is approved. There is opposition to the proposed terms for the purchase of generating stations. Parliament is urged not to break faith with those who have invested their capital on the strength of the powers conveyed by earlier legislation. Having regard to the fact that practically every industry in the country is concerned directly or indirectly with electricity supply, it is more fitting that the Electricity Commissioners should be responsible to Parliament through the President of the Board of Trade, and should not be under the Ministry of Ways and Communications. This point is strongly emphasised.

THE death is announced, at sixty-seven years of age, of Prof. Emil Fischer, professor of chemistry in the University of Berlin, foreign member of the Royal Society, and Nobel laureate in chemistry in 1902.

THE death is announced, in his seventy-fourth year, of Dr. Elwyn Waller, who from 1885 to 1893 was professor of analytical chemistry at the School of Mines, Columbia University. From 1872 to 1885 Dr. Waller was chemist to the New York Health Department. He was the author of several text-books on chemistry.

MRS. MENTEITH OGILVIE has presented to the Natural History Museum the fine collection of British bird-skins formed by her late husband, Dr. Menteith Ogilvie. It consists of nearly 1800 specimens, many of the species being represented by large series. The collection is in a very good condition, each bird being carefully identified and labelled, with full data. The birds of prey are particularly well represented. There are three examples of the hen harrier, a decreasing British species, and seven of Montagu's harrier, which is a somewhat rare spring and summer visitor. There is a very large series of the sparrowhawk, showing every change and phase of plumage from the nestling in its various stages to the adult bird. There are also good series of the great crested grebe from Norfolk and Suffolk, of the Slavonian grebe, and of the little auk, also from Norfolk and Suffolk.

DR. H. R. MILL has retired from the position of director of the British Rainfall Organisation and from the editorship of "British Rainfall" and *Symons's Meteorological Magazine,* which he has carried on since 1901. Serious impairment of eyesight consequent on overwork led Dr. Mill to make arrangements for retiring in 1914, when the outbreak of the war caused him to postpone the step; he now finds his health unequal to the strain of adapting the work to post-war conditions. The association of voluntary rainfall observers in all parts of the British Isles numbered 3500 nineteen years ago; it had reached 5500 in 1914, and, after falling to about 5100 during the war, the number is again increasing. The collection and publication of rainfall data will not be interrupted by the changes consequent on Dr. Mill's retirement.

THE sudden death on July 5 of Mr. John Hopkinson at his home in Watford is a sad loss to the pursuit of natural knowledge, both in Hertfordshire and in wider fields. It was so far back as 1875 that Mr. Hopkinson founded the Watford (now Hertfordshire) Natural History Society, and for more than forty years the promotion of its interests had been his chief concern. The eighteen volumes of Transactions are sufficient evidence of the success of his efforts; to them he contributed frequently on meteorological, phenological, and geological topics, and the whole series has had his meticulous editorial care; and his sturdy Yorkshire shoulders carried a good deal more than the local society. The admirable County Museum at St. Albans arose from his proposal, and he was the originator of the annual conference of delegates from provincial scientific societies held in connection with the British Association. For some fifteen years he had been secretary of the Ray Society, and always the helpful friend of naturalists of all kinds. Mr. Hopkinson was active to the last, and few men have made better use of seventy-four years.

BY the death of Dr. John Inglis on July 13 the Clyde loses one of its best known pioneers in scientific shipbuilding. An account of Dr. Inglis's career appears in *Engineering* for July 18, to which we are indebted for the following particulars. He was born in 1842, the eldest son of Anthony Inglis, who founded the firm of A. and J. Inglis in 1837. He was educated at the Glasgow Academy and at Glasgow University, where he came under the influence of the brothers Thomson, Lord Lister, Rankine, Blackburn, and others. He became manager of the shipbuilding yard at twenty-five years of age. He was amongst the first to adopt the principle of progressive-speed trials on the measured mile and of careful study of the results achieved. Dr. Inglis was associated with Dr. Froude's method of tank experiments with models of different forms and with comparative screw propellers. He was the first on the Clyde to carry out inclining experiments on completed vessels with the view of determining their stability and of assisting towards accurate loading. He was also a pioneer in the determination of longitudinal stresses, and conducted many experiments on a practical scale. He was vice-president of the Institution of Naval Architects, and president of the Institution of Engineers and Shipbuilders in Scotland in 1893, and of the Institute of Marine Engineers in 1898. Much of his private time was devoted to the advancement of the national organisations and institutions in Glasgow. In 1898 the honorary degree of LL.D. was conferred upon Dr. Inglis by the University of Glasgow.

As a result of the establishment of the Ministry of Health, the medical staffs of the Local Government Board and of the National Health Insurance Commission have been brought together to form the main portion of the medical staff of the Ministry, but on a newly organised system and with considerable additional posts. The Minister has appointed Sir George Newman as Chief Medical Officer of the Ministry, with status corresponding with that of a Secretary of the Ministry. By arrangement between the President of the Board of Education and the Minister, Sir George Newman is to retain his position as Chief Medical Officer of the Board of Education. Five new posts of Senior Medical Officer have been established, and to these the following appointments have been made:—Dr. G. S. Buchanan, Dr. Janet M. Campbell, Dr. F. J. H. Coutts, Mr. A. W. J. MacFadden, and Mr. J. Smith Whitaker. The whole of the rest of the established medical staff of the Ministry will be in one grade to be known as Medical Officers. The following appointments have so far been announced:—Miss Irene C. D. Eaton, Dr. Major Greenwood, Miss Florence B. Lambert, and Dr. Jane H. Turnbull. Besides this regular staff, arrangements have been made whereby the Ministry may secure the services, from time to time, of specialists and others on a part-time basis. Amongst these are included at present the following:—Dr. Maurice Craig, Col. L. W. Harrison, and Sir David Semple.

BY direction of the President of the United States, the U.S. Distinguished Service Medal has been awarded to Lt.-Col. S. J. M. Auld, Royal Berkshire Regiment, British Army, "for exceptionally meritorious and distinguished services rendered the United States Army while serving as Liaison Officer between the British and American Chemical Warfare Services." Col. Auld, who is professor of agricultural chemistry at University College, Reading, commanded the British Gas Warfare Mission to the United States, other well-known members of which included Major H. R. Le Sueur and Major H. W. Dudley. This Mission put before the Americans everything about gas warfare *ab initio,* and Col. Auld was responsible for organising the American Chemical Warfare Service, which developed into the largest gas service of all the combatant armies. When the armistice was signed the United States were manufacturing nearly twice as much gas as all the other combatant nations (including Germany) put together. The American respirator was an improved copy of the British box respirator. The field training was also based on British experience. The exchange of manufacturing, design, and research experience between the two nations was absolutely complete, the relationship between the two Chemical Warfare Services being closer than in any other branch of the Service, and doing much to consolidate the cordial understanding already existing between the chemists of the two countries.

MR. R. A. SMITH describes in the issue of *Man* for July a discovery of flint implements from Victoria West, in the heart of the Great Karroo, South Africa. Among them are examples of what are known as "tortoise-cores," best known in Europe from Northfleet, in Kent, and from Montières, near Amiens, and dating from the period of Le Moustier, to which they are probably confined. The core was prepared with the object of getting an ovate flake-implement from the upper face by a final blow on the faceted bulb. This, if successful, was a special case of the Levallois flake. Those from Victoria West are rather pointed at one end, and generally struck from the left edge near the point; in a few cases the detaching blow was struck on the right of the point.

IN a paper entitled "Customs Connected with Death and Burial among the Roumanians," published in the June issue of *Folk-lore*, Mrs. A. Murgoci has collected much interesting information less known than it deserves to be in western Europe. The accounts of the death feasts are curious, still more the custom of disinterring the dead seven years after burial; when a death feast is given for the last time, the bones are washed in wine, put in a smaller coffin, and reburied. At present the priests are overburdened with work, for not only have they an unusually large number of deaths to deal with, but they are now beginning to be occupied in digging up those who died before the war. On the Monday after Easter Monday women put the red shells of the Easter eggs into water in the hope that they may be thus conveyed to the Blajini, the good men who live in some other world and are ignorant of what passes in this. When they see the egg-shells floating within their view, they know that Easter has come, and they, too, rejoice.

THE South London Entomological and Natural History Society takes a high place among associations of the kind for the thoroughness of its work and for the excellence of its published Proceedings. The activities of the society are chiefly entomological, and the contributions of many of its members to our knowledge of the morphology and ontogeny of native insects are of great value. The last published volume of Proceedings contains a well-written summary of recent work in economic entomology, both British and foreign, delivered as his annual address by the president, Mr. Stanley Edwards. A careful analysis of variation in the wing-markings of *Epinephele tithonus*, compared with other species of Satyrid butterflies, and illustrated by two excellent photographic plates, is contributed by Mr. G. Wheeler. Other elaborate studies of variation in Lepidoptera are furnished by Mr. H. J. Turner and Mr. A. Sich. The reports of meetings, with notes of discussions and the exhibition of specimens, are adequately given, and accounts are included of various excursions and visits, including one to the John Innes Horticultural Institute at Merton, and another to Wimbledon Common, where the natural features of the site appear to have suffered less interference of late years than might have been expected. There is a brief notice of a lecture by Prof. A. Dendy on sponges, and an abstract of a lecture by Miss G. Lister on the Mycetozoa. Altogether there is reason to congratulate the members on the healthy condition of their society, and we should not omit to mention that a full index much enhances the value of the present volume.

THE Bulletin of the Imperial Institute, vol. xvii., No. 1, for this year contains an important article on the cocoa production of the Empire. The quantity of cocoa produced in British countries in 1913 was more than three times the amount consumed in the United Kingdom, yet this country obtained only about one-half of its supply from these sources. Large quantities of prepared cocoa and chocolate were also being imported from foreign countries which had been manufactured there from British-grown cocoa. During the war the position improved, and about 86 per cent. of the total imports came from British possessions in 1917. The money value of the imports in 1916 was 6¾ million pounds sterling, so that the importance of the matter can readily be realised. Two points are worthy of special mention: first, the remarkable growth of the cocoa industry on the Gold Coast, which colony started to export cocoa in 1891; and, secondly, the enormous increase in the consumption of cocoa in the United States in recent years. The consumption has trebled since 1913, and about one-half of the total quantity produced in the world now goes to the States.

THE possibility of growing New Zealand flax (*Phormium tenax*) on a commercial scale in the British Isles has for many years been under consideration, and the publication of an important paper on the subject in *Kew Bulletin*, No. 4, is of considerable interest. From the account there given it is clear that in south-west Ireland, south-west Scotland, and possibly in the south of England, the successful cultivation of New Zealand flax is a definite possibility. The article, which mainly consists of an account of Lord Ventry's successful experiments in co. Kerry, is illustrated by several photographs of New Zealand flax under cultivation in Ireland showing a remarkably vigorous growth. The fibre of this Irish-grown flax has been tested at Belfast, and has been found almost as good as "Good-fair" imported fibre from New Zealand, which was valued in July, 1914, at 32*l*. per ton. As paper-making material, the leaves have also been very well reported on by the Irish Paper Mills Co. near Dublin. The great value of New Zealand flax, however, is its fibre, which is used for making binder twine and high-grade string and cord. As the demand for this is a very heavy and rising one, the possibility of growing New Zealand flax for the purpose in the British Isles is of considerable importance. It is pointed out in the article that only certain parts of the United Kingdom are suitable for the growth of New Zealand flax as a commercial undertaking, but as the results so far obtained are promising, it is to be hoped that every encouragement will be given to the enterprise, which promises to yield a sound financial return to the impoverished farmers in the south-west of Ireland in particular.

THE U.S. Bureau of Standards Technologic Paper No. 128 (copies of which may be obtained on application to the Bureau) deals with the effect of solar radiation upon balloons from the thermal point of view. After discussing the characteristics of radiation from the sun and the effects of its absorption by balloon fabric, the authors give the results of reflection and transmission measurements on nineteen different samples with Coblentz's apparatus, using light from the sun and from a nitrogen-filled tungsten lamp with copper chloride filter. With a model airship 12 ft. × 3 ft. the temperatures of the fabric and of the contained gas were determined in sunlight; the temperature-rise of the upper fabric was found to be proportional to the cosine of the angle between the sun's rays and the normal to the surface; the minimum temperature occurred just below the shadow line, and not at the bottom. In the lower half of the balloon the temperature of the gas was uniform, although there was a difference of 25° C. between this and the gas temperature at the top. It is calculated that in still air as much as 80 per cent. of the total heat loss from the upper surface of the model might be due to radiation from the fabric. For obtaining the minimum heating effect on an airship in sunlight the use of aluminium-coated fabric is recommended, since this also affords good protection against actinic light.

IN view of the successful round voyage of the naval airship R 34, great interest is attached to a fully illustrated account of this vessel which appears in *Engineering* for July 18. The vessel has a length of 645 ft. over all, and a maximum diameter of 78 ft. 9 in. Its gas capacity is about 2,000,000 cub. ft., giving a gross lift of 60 tons under standard conditions. The disposable lift is just under 30 tons. The hull is of fine stream-line form, and is constructed of main transverse frames spaced 10 metres apart, and built in the form of a polygon with thirteen sides. The frames are joined at each angle of the polygon by longitudinal girders, and there are intermediate frames in each space, both transversely and longitudinally. The exterior polygon of twenty-six sides thus formed has the outer cover stretched over it. The girders are constructed of duralumin. There are eighteen gas-bags, composed of high quality single-ply cotton fabric, lined with rubber on the inner surface. On this surface goldbeaters' skins are stretched and secured with rubber solution, and the whole is then varnished over. Each gas-bag has an automatic relief valve. There are five cars, one for navigational purposes, and all the others contain engines. The five engines are of 270 h.p. each, and give a speed of 55 knots in still air. The photographic illustrations of the ship under construction and in flight are particularly interesting, and give very clear views of the details of construction.

MESSRS. HODDER AND STOUGHTON have in the press the New Teaching Series, which has been arranged to meet new demands in education as to method and curriculum. The subjects of the volumes in hand include:—Chemistry from the Industrial Viewpoint, Applied Botany, Industrial Geology, Geography of Commerce and Industry, Chemistry and Bacteriology of Agriculture, Everyday Mathematics, Mathematics of Engineering, Foundations of Engineering, Mathematics of Business and Commerce, and Industrial History.

MESSRS. H. K. LEWIS AND CO., LTD., have removed their publishing, wholesale, and advertisement departments to 28 Gower Place, W.C.1. The change not only provides larger and more convenient accommodation for publishing work, but the space vacated in the old premises affords much needed additional room for the library and bookselling business. A new and convenient reading-room is to be added to the library over the present library room.

MESSRS. LONGMANS ask us to say, in correction of an announcement in last week's NATURE, that though the edition on large paper of "A Naturalist's Sketch Book," by A. Thorburn, which they will publish in the autumn, will be limited to 105 copies, the ordinary edition of the book will not be limited in number.

THE offices of the Imperial Mineral Resources Bureau have been moved from 14 Great Smith Street to 2 Queen Anne's Gate Buildings, Westminster, S.W.1.

## OUR ASTRONOMICAL COLUMN.

A BRIGHT METEOR.—A large meteor with unusually slow motion was observed at Bristol on July 20, 11.2 G.M.T.; it had a double nucleus, and passed over 42° of the sky in 12 seconds. The observed path was from 37°+47° to 4°+15½°. The meteor was of a red colour, like Mars, and probably from a radiant in Leo at about 155°+25°. It is curious that the great fireball seen in America on July 20, 1860, had a radiant point in the same region of the sky, and may be assumed to have been derived from the same cometary system. Further observations of the meteor of July 20 last would be valuable, and Mr. W. F. Denning, 44 Egerton Road, Bristol, will be glad to receive any.

THE LIGHT OF THE AURORA AND THE AURORAL LINE.—Observation of the brightness of the background of the sky by various observers has shown that it must be due to some other cause than the diffused light of the stars themselves, and the suggestion has been made that this is the effect of the existence of a permanent aurora. In the *Astrophysical Journal* for May Prof. Slipher publishes an account of some spectrographic observations which have a direct bearing on the point. He says that during three and a half years something like one hundred spectrograms were made of the night sky, and every one of them recorded the chief auroral line, so that during this period of time auroral illumination of the sky was found to be present on every night that an exposure was made for detecting it. Incidentally, Prof. Slipher made a determination of the wave-length of the green auroral line, which he finds to be longer than the generally accepted value, $\lambda$ 5571. Prof. Frost, in an editorial note, corroborates the fact from inspection of one of the spectrograms that the green line falls at a point of greater wave-length than the solar line $\lambda$ 5573, and it appears that the wave-length of the auroral line is substantially $\lambda$ 5578·05.

THE SPIRAL NEBULÆ.—A reprint from the Journal of the Washington Academy of Sciences for April 19 gives an abstract of a lecture delivered by Prof. H. D. Curtis, of the Lick Observatory, on certain modern theories of the spiral nebulæ. The author forms the opinion that these nebulæ are island universes, and not part of our galactic system, a line of argument adduced to show this being as follows:—The spiral nebulæ have large radial velocities shown by the spectroscope, their average speed being nearly five hundred miles a second, but by repeating photographs taken about thirteen years ago and comparing them with the earlier ones, Prof. Curtis finds no evidence of proper motion or motion at right angles to the line of sight which it is to be expected these objects should have, since their space velocity is high. The conclusion to be drawn is that the cross-motion does not show because the nebulæ are very remote, so remote that they must be far outside the generally accepted limits of the bun-shaped figure known as our stellar system. An argument in favour of the island universe theory, drawn from the appearance of Novæ, may be repeated. The brighter Novæ of the past have almost invariably been located in or close to our Milky Way, and therefore have evidently been part of our stellar system. In the course of a few years a dozen Novæ have been found in spiral nebulæ, all very faint, and the life-history of these has been essentially the same as that of the brighter Novæ. There is thus a presumption, though not a very rigid proof, that the phenomena of the spirals are similar to those of our galaxy, and therefore that they themselves are galaxies.

## CHEMISTS IN CONFERENCE.

THE Society of Chemical Industry held its annual meeting in London on July 15–18, and, in order to emphasise the fact that its outlook is industrial rather than academic, the conferences took place in the City, and not, as hitherto, in South Kensington. The opening meeting was held at the Mansion House, and the society was welcomed by the Lord Mayor; other conferences were held at the Salters' Hall, Goldsmiths' Hall, and Clothworkers' Hall, and the foreign delegates were privileged to lunch in the picturesque and old-world hall of the Girdlers' Company.

It has already been announced in these columns that an Inter-Allied Chemical Council has been formed for the promotion of co-operation between the chemists of Belgium, France, Great Britain, Italy, and the United States. During the last year or so there has also grown into existence an International Research Council, which has met in Rome and Paris, and is this week holding an important conference in Brussels. This council contemplates the organisation of research and publication in all branches of science and in all countries, except Germany and Austria, and there was a good deal of discussion among the British and Allied chemists at their conferences last week as to how the Inter-Allied Council could fit into the scheme of organisation contemplated by the International Research Council. It was at length decided to announce that the Inter-Allied Chemical Council was of opinion that this body should be the chemical section of the International Research Council, and should do all the work of organisation and publication which was required in connection with chemistry, both pure and applied. A deputation was sent to Brussels to express this view and to co-operate with the other *savants* there assembled. Amongst the delegates to Brussels we may mention Prof. Chavanne, Dr. Lucion, and M. Timmermans, representing Belgium; Profs. Moureu and Béhal, representing France; Sir William Pope and Dr. Ruttan (of Canada), representing the British Empire; and Lt.-Col. Bartow, Dr. Parsons, and Dr. Washburn, representing the United States. It is understood that Canada and Poland have expressed a wish to be represented on the Inter-Allied Chemical Council, and are now admitted as such, and that the other Allies who have signed the Treaty of Peace will be asked to become constituent bodies.

Among the papers read at the Mansion House on July 15 was a very eloquent and interesting appreciation of the late Sir William Ramsay by Prof. C. Moureu, the president of the Inter-Allied Council. Prof. Moureu described the researches of the late Lord Rayleigh on the density of nitrogen, and gave an account of the excitement produced at the British Association at Oxford in 1894 when Lord Rayleigh and Sir William Ramsay announced their discovery of argon. He mentioned as characteristic of Sir William Ramsay the speed with which he followed up a hint given in a letter from Sir Henry Miers as to a gas contained in cleveite and detected by Hillebrand. This led to the discovery of helium, which was spectroscopically detected in the sun so long ago as 1868.

Prof. Moureu gave some account of his own original work on the occurrence of helium in fire-damp and in the gases given off by underground springs, and sketched the history of the discovery of neon, krypton, and xenon. Only those who have paid attention to the recent publications are aware that helium occurs to the extent of 6 per cent. in the gases given off by the spring at Maizières, in the Côte d'Or, and to the extent of 10 per cent. in the gas of the spring at Santenay, also in the Côte d'Or. Moreover, krypton, argon, xenon, and neon are usually found in the subterranean gases, and the relative proportions of these four gases are fairly constant. The explanation is suggested that these gases, being chemically inactive, have remained in a constant proportion since the days when our globe was a nebular mass without form and void. It was Sir William Ramsay himself who predicted the use of helium for filling balloons—a prediction which has been recently verified by the work done in the United States under the superintendence of Dr. Cottrell.

An important conference on the production and consumption of sugar within the British Empire was held at the Clothworkers' Hall, the Earl of Denbigh being in the chair. A number of experts took part in the discussion, and a voluminous report is now being prepared for publication.

A group of papers on power plant in chemical works occupied a whole day; these included a paper on waste heat boilers by Capt. C. J. Goodwin and a paper on surface combustion boilers by Prof. W. A. Bone and Mr. P. Kirke. Several speakers directed attention to possible economies in the use of fuel—a matter which is now of the utmost importance to the whole nation.

The conference on dyestuffs was largely attended, and a paper by Dr. Herbert Levinstein on the intimate connection between the German dye manufactures and the supply of explosives and poison gases should make our politicians think furiously. Germany, notwithstanding the Treaty of Peace, is left in the position that she can easily, at a few hours' notice, commence the manufacture of explosives and poison gas on a very large scale. In this country we have at the moment no manufacture which can proceed during peace and at once be switched on to warlike purposes. Mr. E. V. Evans, in his paper on the manufacture of intermediate products in the dyestuff industry, showed how desirable it is to conduct the manufacture of these in a few works on a large scale rather than, as now, the manufacture on a small scale in many works.

There were good papers on other topics dealing, perhaps, with rather technical matters, and a number of papers on chrome tanning and on recent developments in the fermentation industries, including one by Sir Frederick Nathan on the manufacture of acetone.

Industrial chemistry is becoming too large a subject for any individual to master, and the tendency to specialise is manifested, not only in the grouping of a number of cognate papers into one conference, but also in the activities of the recently formed chemical engineering group of the society. On the whole, the papers were of considerable importance, and show that, though the chemists may be tired by their war-work, they are not exhausted.

## PHYSIOLOGY AND METAPHYSICS.

A JOINT session of the Aristotelian Society, the British Psychological Society, and the Mind Association has been held annually, though more or less informally, since 1908. This year an attractive and more extended programme was provided on July 11–14, and hospitality was offered by Bedford College, the most delightfully situated and admirably appointed of the University of London colleges. The result was a very large increase in the membership and a sustained interest in the session. Members were furnished in advance with the whole of the written communications constituting the Proceedings. This had the advantage that at every meeting the papers were taken as read, and the leaders of the discussions could concentrate at once on the important points in theory or criticism of theory which they had set forth.

The subject of discussion at the first meeting was "Propositions: What They Are and How They Mean." The paper was by Mr. Bertrand Russell. It was the outcome of a philosophical research into the tenability of the behaviourist theory in psychology. The neutral monism which forms the basis of this theory had proved very attractive to Mr. Russell, and he put forward as his own view that it is true in so far as that the psychical and the physical are not distinguishable by the stuff of which they are made, but by the order of the causal laws to which they are amenable. He parted from behaviourism, however, on the question of "images." So far as he had been able to go at present, he was convinced that there are images, and he could see no way of interpreting them in physical terms. An interesting discussion followed, led by Dr. G. E. Moore, who presided.

The second meeting attracted the largest audience of the session. The subject was a symposium on "Instinct and the Unconscious," to which Dr. W. H. R. Rivers, Dr. C. S. Myers, Dr. C. G. Jung (of Zurich), Prof. Graham Wallas, Dr. J. Drever, and Dr. W. McDougall contributed. Sir Leslie Mackenzie presided. The interest of this discussion centred round the neurological and psychological discoveries in regard to war-neuroses. Dr. Jung received a warm welcome, and surprised everyone by the ease and fluency with which he expounded his theory in English. The theory created a lively impression. At a subsequent meeting its more philosophical aspect, particularly its relation to Bergson's doctrine of a vital impulse, was the subject of a discussion opened by Mr. J. W. Scott.

The third meeting was a symposium on "Space, Time, and Material: Are They, and if so in what Sense, the Ultimate Data of Science?" Sir Joseph Larmor presided. Sir Oliver Lodge, who had contributed one of the papers, was unavoidably absent, and a reply to a criticism of his thesis was read. The other contributors were Prof. A. N. Whitehead, Prof. J. W. Nicholson, Dr. Henry Head, Mrs. Adrian Stephen, and Prof. Wildon Carr. Two problems emerged in the discussion: the physical problem of continuity and the physiological problem of the nature of the mechanisms and neurological contrivances which condition conscious experience. Prof. Whitehead contended that the first chapter in science, *i.e.* in the systematisation of Nature, must deal with an event. Process is the fundamental fact which requires explanation; there is no element in experience prior to and simpler than an event.

The fourth meeting was devoted to the metaphysical problem of the relation of the finite to the infinite, or, in the terms of the symposium, "Can Finite Minds be Included in the Mind of God?" Lord Haldane presided. The papers were by the Dean of Carlisle, Dr J. H. Muirhead, Dr. F. C. S. Schiller, and the Bishop of Down.

The fifth and final meeting was a symposium on "Is there 'Knowledge by Acquaintance'?" The papers were by Prof. G. Dawes Hicks, Dr. G. E. Moore, Dr. Beatrice Edgell, and Mr. C. D. Broad. Prof. W. R. Sorley was in the chair.

The dominant note in the discussions was, to most of those taking part, the physiological problem. Dr. Head's description of his researches, based on the treatment of war injuries, into the function of the cerebral cortex, and his theory of the survival of older responses beneath the superposed control of the higher centres, though freely criticised, was felt to have important consequences both for psychological and epistemological theory. Also, it left the impression of a new and unsuspected approach to one another of science and philosophy.

The meeting in 1920 is to take place at Oxford, and it is intended to invite the participation of the Société Française de Philosophie.

## A LEAGUE OF UNIVERSITIES.

A CONFERENCE of Universities was held at the Imperial Institute on July 18. It was convened in order that representatives of British universities, including such members of the universities of the King's Dominions overseas as are still in England in connection with the war, might take counsel with their colleagues from the U.S.A. Notwithstanding the difficulties created by Peace Day, especially in regard to finding hotel accommodation, the conference was well attended. The subject for discussion was the contemplated extension of the activities of the Universities Bureau. Representatives were invited to give expression to their views regarding the ways in which the Bureau might be of greater service to the universities.

The chairman, Sir Donald MacAlister, was able to announce that, the Treasury having, on the advice of the President of the Board of Education, promised to the Bureau a non-recurrent grant of 5000*l.*, provided the universities made adequate provision for its maintenance, almost all the universities of the United Kingdom had already adopted a proposal made at the last meeting of the conference for each to contribute a sum of 100*l.* per annum to the Bureau funds, and two of the university colleges had promised 50*l.* each. The Treasury grant is intended to enable the Bureau Committee to acquire and furnish premises suitable for the accommodation of the staff and for the reception of visiting professors and immigrant students from the Dominions and foreign countries. Probably in a short time it will be possible to announce the address of the new headquarters.

When the delegates who attended the congress of 1912 decided that it was desirable that a "clearing-house" for universities should be established, they were thinking of it chiefly as an agent for promoting co-operation amongst the universities of the Empire, although its international relations were not absent from their minds. No one then could have foreseen that during the autumn of 1914 and the year which followed, the secretary of the Bureau would be in correspondence with all the universities and colleges of the United States and other neutral countries, or sending them parcels of State papers, books, and pamphlets on the causes of a great war, the responsibility for it, and the moral issues which it raised. Nor could anyone have foreseen that, as an outcome of the war, there would be an urgent demand for co-operation amongst the universities of the Allied and neutral countries, and especially for the interchange of teachers and graduate students, on a scale which will appreciably affect our knowledge of one another's ways of thought and trend of sentiment.

All who look to the League of Nations as the only guarantee of peace recognise that one of its strongest supports would be a League of Universities. In illustration of what may be done to promote such a league, the nine representatives of the universities of the United Kingdom and Capt. Holme, who represented the universities of Australasia, gave an account of their experiences and of the impressions which they received during their recent visit to France as guests of the French Republic, and Dr. Fish, on behalf of Dr. Duggan, the director, who was detained in France, described the aims of the new American Institute of International Education.

## SCIENCE IN INDUSTRY.

### Lectures at the British Scientific Products Exhibition.

IN the course of his lecture on "Explosives" at the British Scientific Products Exhibition on July 18, Mr. James Young, Royal Military Academy, said that during the war ammonal was found to be very suitable for use in military mines and in trench-warfare weapons, being safe and powerful, and having a moderate velocity of detonation. It is equally suitable for industrial use, and the expensive constituent —aluminium—can be reduced to 3 per cent. Blastine was also much used for the same purposes, and as the main constituent, ammonium perchlorate, is now made by electrolytic processes, it has a promising future in industry. It is much more sensitive than ammonal, and therefore not so safe to the users. The invention of amatol, a mixture of T.N.T. and ammonium nitrate, was of great value, and doubled our resources of shell high explosives. As compared with picric acid (lyddite), it is safer to handle, costs about one-third, but is not so shattering, owing to the lower velocity of detonation. It is also suitable for industrial use, and mixtures with as little as 10 per cent. of T.N.T. are effective.

Referring to the important subject of a national factory for the fixation of nitrogen, Mr. Young pointed out that our industries are dependent on national security, which again depends on an Army and Navy provided with an adequate supply of explosives, so that if some industries are key industries, explosives are a master-key. The materials for these should, so far as possible, be home products. Now, nitrates are the foundation of nearly all our military explosives, and most of the others in use, and practically all our nitrates, come from far overseas. If we had been cut off from our supplies during the war it is doubtful if our chemists could have filled the gap in time, for the new artificial processes for the fixation of nitrogen require much experience for their efficient working. A great national factory for the fixation of nitrogen should be established in England without delay. We are already behindhand. The Germans, with more experience, were able to make their own nitric acid for carrying on the war. America has already established a national factory. Millions are to be spent on airships, with problematic results, but, with experience, good returns from such a factory should be a certainty. It would have unique advantages. The principal raw materials are air and water. Nitrates and ammonium compounds are in great demand as fertilisers. In peace the main production would be used as fertilisers and for industrial explosives, and be ready to be switched on to war, if war should come. It would at the same time increase the security of the nation and its agricultural prosperity.

Mr. L. Bairstow pointed out, in his lecture on July 21, that the record of some of the striking developments in aviation in the war period has been presented in such a way as to form an indicator of further progress. In forming the Advisory Committee for Aeronautics in 1909 the British Government showed a wise foresight, for in the hands of a body of men of science inquiries have been systematised and coherence given to a literature which has had a profound influence on British aviation. Attention was directed to specific cases of valuable experimental work both on the model and full-scale. In many ways the use of models under carefully controlled laboratory conditions forms the best means of attack on a new problem. There are scale effects which reduce the accuracy of direct application to the full scale, but many of them are known, particularly those for the main parts. A diagram was given which illustrates the extremely close relation between tests on large and small wings; the experiment is one possessing a considerable degree of accuracy, and the distribution of pressure is sensitive to changes of angle of incidence. The agreement is probably complete within the accuracy of the full-scale experiments, and a committee formed to discuss the value of model experiments concluded by saying:—"It is of great importance that such information should be increased and its use extended by further systematic full-scale research." In dealing with stability, records were shown of the disturbed motions of aeroplanes. Easily obtained, these records show whether an aeroplane is stable or unstable and the degree of its stability. Several types of disturbance were shown, including those of an aeroplane which tends to turn upside down, one which "hunts," *i.e.* shows an increasing oscillation, and others which are stable. The motions indicated by the records are calculable on the mathematical basis given by Prof. Bryan if use be made of the resistance derivatives found in the aerodynamical laboratories. It is in the collection of the latter from specially conducted experiments that the immediate future holds its most important research work.

A conference on "Patents in Relation to Industry" will be held at the exhibition on Thursday, July 31, at 4.30 p.m. Lord Moulton will preside, and among those who will take part in the discussion are Sir Robert Hadfield, Mr. W. S. Reid (chairman of council of the Institute of Inventors), Mr. W. R. Bousfield, Mr. Douglas Leechman, Mr. W. M. Mordey, Mr. James Swinburne, and Sir G. Croydon Marks.

## COTTON AND COTTON-SEED INDUSTRIES.

IN an address delivered by invitation before the Manchester Textile Institute on May 28, Mr. E. C. de Segundo discussed the interdependence of the cotton and the cotton-seed industries. Until about 1860, cotton-seed from the plants yielding the cotton imported to Lancashire was a waste product. The value, to the United States alone, of this once waste product was, just before the war, with an average cotton-seed crop, from twenty to thirty millions sterling. Some 95 per cent. of the seed now utilised retains, however, residual fibre to the extent of from 2 per cent. in lightly fibred Indian seed to 12 per cent. of the seed-weight in American Upland, Uganda, and other woolly varieties. This residual fibre includes, besides the "fuzz" proper, some "staple" which has escaped the gin and other fibres too short to be included in "staple." Some part of the residual fibre which is not "fuzz" has long been recovered by saw-linting machines, as "linters," mainly marketed in Germany.

The successful removal of the proper "fuzz" without injury to the seed or to the short fibres has been a more difficult problem. The potential value of "fuzz" has long been recognised, but the attempts to separate the "fuzz" at first gave a product marked by the defect of admixture with pieces of seed-shell and foreign matter. Since 1909 a machine has been in use which turns out "fuzz" in a clean, marketable form free from this defect. Before the war 2000 tons of these short fibres had been imported to Britain for paper-making. During the war 8000 tons of this "hull-fibre" have been used by one United States firm in making explosives.

American practice removes the residual fibre in three steps. Some 2 per cent. (45 lb. per ton of seed) is recovered in the saw-linting machine as "linters," and about 3 per cent. (67 lb. per ton) in the seed-defibrating machine as "seed-lint"; while some 12 per cent. (112 lb. per ton of seed) is obtained in the hull-defibrating machine as "hull-fibre." All three products now command high prices. Calculated on a pre-war basis, the three grades aggregate 45*s.* per ton of seed; the cost involved is 11*s.* 6*d.* per ton; and the net extra return is about 33*s.* per ton.

The British milling system, which crushes the entire seed, prevents complete recovery of the residual fibre. Even so, and assuming that 2 per cent. of fibre is left on the seed, 2 per cent. could still be recovered as "linters" and 6 per cent. as "seed-lint." The additional value should be 32*s.* per ton of seed, provided the recovery be effected in the oil-milling operation. But it will be preferable, whenever possible, to defibrate the seed in the country of origin. Were Uganda seed defibrated at the ginning in Uganda there would result:—(*a*) A profit on the "linters" and "seed-lint" recovered; (*b*) a reduction of the space occupied by the defibrated exported seed, with a consequent saving of 25 per cent. or more in ocean freight; (*c*) a diminution of the liability of cotton-seed to heat during the voyage and a consequent reduction in insurance rates; and (*d*) a probable increase in the price paid for defibrated as compared with "fuzzy" seed. At pre-war rates these factors, taken conjointly, should mean an increase of 50*s.* per ton in the prices paid for Uganda seed in the British market.

## COLLISION OF α-PARTICLES WITH LIGHT ATOMS.[1]

THE discovery of radio-activity has not only thrown a flood of light on the processes of transformation of radio-active atoms; it has at the same time provided us with the most powerful natural agencies for probing the inner structure of the atoms of all the elements. The swift α-particles and the high-speed electrons or β-rays ejected from radio-active bodies are by far the most concentrated sources of energy known to science. The enormous energy of the flying α-particle or helium atom is illustrated by the bright flash of light it produces when it impacts on a crystal of zinc sulphide, and by the dense distribution of ions along its trail through a gas. This great store of energy is due to the rapidity of its motion, which in the case of the α-particle from radium C (range 7 cm. in air) amounts to 19,000 km. per second, or about 20,000 times the speed of a rifle-bullet. It is easily calculated that the energy of motion of an ounce of helium moving with the speed of the α-particle from radium C is equivalent to 10,000 tons of solid shot projected with a velocity of 1 km. per second.

In consequence of its great energy of motion the charged particle is able to penetrate deeply into the structure of all atoms before it is deflected or turned back, and from a study of the deflection of the path of the α-particle we are able to obtain important evidence on the strength and distribution of the electric fields near the centre or nucleus of the atom.

Since it is believed that the atom of matter is, in general, complex, consisting of positively and negatively charged parts, it is to be anticipated that a narrow pencil of α-particles, after passing through a thin plate of matter, should be scattered into a comparatively broad beam. Geiger and Marsden showed not only that much small scattering occurred, but also that in passing through the atoms of a heavy element some of the α-particles were actually turned back in their path. Considering the great energy of motion of the α-particle, this is an arresting fact, showing that the α-particle must encounter very intense forces in penetrating the structure of the atom. In order to explain such results, the idea of the nucleus atom was developed in which the main mass of the atom is concentrated in a positively charged nucleus of very small dimensions compared with the space occupied by the electrons which surround it. The scattering of α-particles through large angles was shown to be the result of a single collision where the α-particle passed close to this charged nucleus. From a study of the distribution of the particles scattered at different angles, results of first importance emerged. It was found that the results could be explained only if the electric forces between the α-particle and charged nucleus followed the law of inverse squares for distances apart of the order of $10^{-11}$ cm. Darwin pointed out that the variation of scattering with velocity was explicable only on the same law. This is an important step, for it affords an experimental proof that, at any rate to a first approximation, the ordinary law of force holds for electrified bodies at such exceedingly minute distances. It was also found that a resultant charge on the nucleus measured in fundamental units was about equal to the atomic number of the element. In the case of gold this number is believed from the work of Moseley to be 79.

Knowing the mass of the impinging α-particle and of the atom with which it collides, we can determine from direct mechanical principles the distribution of velocities after the collision, assuming that there is no loss of energy due to radiation or other causes. It is important to notice that in such a calculation we need make no assumption as to the nature of the atoms or of the forces involved in the approach and separation of the atoms. For example, if an α-particle collides with another helium atom, we should expect the α-particle to give its energy to the helium atom, which could thus travel on with the speed of the α-particle. If an α-particle collides directly with a heavy atom, *e.g.* of gold of atomic weight 197, the α-particle should retrace its path with only slightly diminished velocity, while the gold atom moves onward in the original direction of the α-particle, but with about one-fiftieth of its velocity. Next, consider the important case where the α-particle of mass 4 makes a direct collision with a hydrogen atom of mass 1. From the laws of impact, the hydrogen atom is shot forward with a velocity 1·6 times that of the impinging α-particle, while the α-particle moves forward in the same direction, but with only 0·6 of its initial speed. Marsden showed that swift hydrogen atoms set in motion by impact with α-particles can be detected like α-particles by the scintillations produced in a zinc sulphide crystal. Recently I have been able to measure the speed of such H atoms and found it to be in good accord with the calculated value, so that we may conclude that the ordinary laws of impact may be applied with confidence in such cases. The relative velocities of the α-particles and recoil atom after collision can thus be simply illustrated by impact of two perfectly elastic balls of masses proportional to the masses of the atoms.

While the velocities of the recoil atoms can be easily calculated, the distance which they travel before being brought to rest depends on both the mass and the charge carried by the recoil atom. Experiment shows that the range of H atoms, like the range of α-particles, varies nearly as the cube of their initial velocity. If

[1] Discourse delivered at the Royal Institution on June 6 by Sir E. Rutherford, F.R.S.

the H atom carries a single charge, Darwin showed that its range should be about four times the range of the α-particle. This has been confirmed by experiment. Generally, it can be shown that the range of a charged atom carrying a single charge is $mu^3R$, where $m$ is the atomic weight, and $u$ the ratio of the velocity of the recoil atom to that of the α-particle, and R the range of the α-particle before collision. In comparison of theory with experiment, the results agree better if the index is taken as 2·9 instead of 3. If, however, the recoil atom carries a double charge after a collision, it is to be expected that its range would only be about one-quarter of the corresponding range if it carried a single charge. It follows that we cannot expect to detect the presence of any recoil atom carrying two charges beyond the range of the α-particle, but we can calculate that any recoil atom, of mass not greater than oxygen and carrying a single charge, should be detected beyond the range of the α-particle. For example, for a single charge the recoil atoms of hydrogen and helium should travel 4 R, lithium 2·8 R, carbon 1·6 R, nitrogen 1·3 R, and oxygen 1·1 R, where R is the range of the incident α-particles. We thus see that it should be possible to detect the presence of such singly charged atoms, if they exist, after completely stopping the α-particles by a suitable thickness of absorbing material. This is a great advantage, for the number of such swift recoil atoms is minute in comparison with the number of α-particles, and we could not hope to detect them in the presence of the much more numerous α-particles.

In order to calculate the number of recoil atoms scattered through any given angle from the direction of flight of the α-particles, it is necessary, in addition, to make assumptions as to the constitution of the atoms and as to the nature and magnitude of the forces involved in the collision. Consider, for example, the case of a collision of an α-particle with an atom of gold of nuclear charge 79. Assuming that the nucleus of the α-particle and that of the gold atom behave like point charges, repelling according to the inverse square law, it can readily be calculated that, for direct collision, the α-particle from radium C, which is turned through an angle of 180°, approaches within a distance $D = 3{\cdot}6 \times 10^{-12}$ cm. of the centre of the gold nucleus. This is the closest possible distance of approach of the α-particle, and the distance increases for oblique collisions. For example, when the α-particle is scattered through an angle of 150°, 90°, 30°, 10°, 5°, the closest distances of approach are 1·01, 1·2, 2·4, 6·2, 12 D respectively.

In the experiments of Geiger and Marsden, the number of α-particles scattered through 5° was observed to be about 200,000 times greater than the number through 150°. The variation with angle was in close accord with the theory, showing that the law of inverse squares holds for distances between $3{\cdot}6 \times 10^{-12}$ cm. and $4{\cdot}3 \times 10^{-12}$ cm. in the case of the gold atom. The experiments of Crowther in 1910 on the variation of scattering of β-rays with velocity indicate that a similar law holds also in that case, and for even greater distances from the nucleus.

We have seen that Marsden was able by the scintillation method to detect hydrogen atoms set in swift motion by α-particles up to distances about four times the range of the incident α-particle. In Marsden's experiments a thin-walled glass tube filled with radium emanation served as an intense source of rays. Since the lack of homogeneity of the α-radiation and the absorption in the glass are great drawbacks in making an accurate study of the laws controlling the production of swift atoms by impact, I have found it best to use for the purpose a homogeneous source of radium C by exposing a disc in a strong source of emanation. Fifteen minutes after removal from the emanation the α-rays from the disc are practically homogeneous, with a range in air of 7 cm. By special arrangements very intense sources of α-radiation can be produced in this way, and in the various experiments discs have been used the γ-ray activity of which has varied between 5 to 80 milligrams of radium. Allowance can easily be made for the decay of the radiation with time.

In the experiments with hydrogen the source was placed in a metal box about 3 cm. away from an opening in the end covered by a thin sheet of metal of sufficient thickness to absorb the α-rays completely. A zinc sulphide screen was mounted outside about 1 mm. away from the opening, so as to allow for the insertion of absorbing screens of aluminium or mica. The apparatus was filled with dry hydrogen at atmospheric pressure. The H atoms striking the zinc sulphide screen were counted by means of a microscope in the usual way. The strong luminosity due to the β-rays from radium C was largely reduced by placing the apparatus in a powerful magnetic field which bent them away from the screen.

If we suppose, for the distances involved in a collision, that the α-particle and hydrogen nucleus may be regarded as point charges, it is easy to see that oblique impacts should occur much oftener than head-on collisions, and consequently that the stream of H atoms set in motion by collisions should contain atoms the velocities of which vary from zero to the maximum produced in a direct collision. The slow-velocity atoms should greatly preponderate, and the number of scintillations observed should fall off rapidly when absorbing screens are placed in the path of the rays close to the zinc sulphide screen.

A surprising effect was, however, observed. Using α-rays of range 7 cm., the number of H atoms remained unchanged when the absorption in their path was increased from 9 cm. to 19 cm. of air equivalent. After 19 cm. the number fell off steadily, and no scintillations could be observed beyond 28 cm. air absorption. In fact, the stream of H atoms resembled closely a homogeneous beam of α-rays of range 28 cm., for it is well known that, owing to scattering, the number of α-particles from a homogeneous source begin to fall off some distance from the end of their range. The results showed that the H atoms are projected forward mainly in the direction of the α-particles and over a narrow range of velocity, and that few, if any, lower velocity atoms are present in the stream.

If we reduce the velocity of the α-particle by placing a metal screen over the source, it is found that the distribution of H atoms with velocity changes, and that the rays are no longer nearly homogeneous. When the range of the α-rays is reduced to 3·5 cm., the absorption of the H atoms is in close accord with the value to be expected from the theory of point charges. It is clear, therefore, that the distribution of velocity among the H atoms varies markedly with the speed of the incident α-particles, and this indicates that a marked change takes place in the distribution and magnitude of the forces involved in the collision when the nuclei approach closer than a certain distance.

In addition to these peculiarities, the number of H atoms is greatly in excess of the number to be expected on the simple theory. For example, for the swiftest α-rays the number which is able to travel a distance equivalent to 19 cm. of air is more than thirty times greater than the calculated value. The variation in number of H atoms with velocity of the incident α-particle is also entirely different from that to be expected on the theory of point charges. The number diminishes rapidly with velocity, and is very small for α-particles of range 2·5 cm.

It must be borne in mind that the production of a high-speed H atom by an α-particle is an exceedingly rare occurrence. Under the conditions of the experiment the number of H atoms is seldom more than 1/30,000 of the number of α-particles. Probably each α-particle passes through the structure of 10,000 hydrogen molecules in traversing one centimetre of hydrogen at atmospheric pressure, and only one α-particle in 100,000 of these produces a high-speed H atom; so that in $10^9$ collisions with the molecules of hydrogen the α-particle, on the average, approaches only once close enough to the centre of the nucleus to give rise to a swift hydrogen atom.

We should anticipate that for such collisions the α-particle is unable to distinguish between the hydrogen atom and the hydrogen molecule, and that H atoms should be liberated from matter containing free or combined hydrogen. This is fully borne out by experiment.

From the number of H atoms observed it can be easily calculated that the α-particle must be fired within a perpendicular distance of $2{\cdot}4 \times 10^{-13}$ cm. of the centre of the H nucleus in order to set it in swift motion. This is a distance less than the diameter of the electron, viz. $3{\cdot}6 \times 10^{-13}$ cm. The general results obtained with α-rays of range 7 cm. are similar to those to be expected if the α-particle behaves like a charged disc, of radius about the diameter of an electron, travelling with its plane perpendicular to the direction of motion.

It is clear from the experiments with hydrogen that, for distances of the order of the diameter of the electron, the α-particle no longer behaves like a point charge, but that the α-particles must have dimensions of the order of that of the electron. The closest distance of approach in these collisions in hydrogen is about one-tenth the corresponding distances in the case of a collision of an α-particle with an atom of gold.

The results obtained with hydrogen in no way invalidate the nucleus theory as used to explain the scattering of α-rays by heavy atoms, but show, as we should expect, that the theory breaks down when we approach very close to the nucleus structure. In our ignorance of the constitution of the nucleus of the α-particle, we can only speculate as to its structure and the distribution of forces very close to it. If we take the α-particle of mass 4 to consist of four positively charged H nuclei and two negative electrons, we should expect it to have dimensions of the order of the diameter of the electron, supposing, as seems probable, that the H nucleus is of much smaller dimensions than the electron itself. When we consider the enormous magnitude of the forces between the α-particle and the H nucleus in a close collision —amounting to 6 kg. of weight—it is to be expected that the structure of the α-particle should be much deformed, and that the law of force may undergo very marked changes in direction and magnitude for small changes in the closeness of approach of the two colliding nuclei. Such considerations offer a reasonable explanation of the anomalies shown in the number and distribution with velocity of the H atoms exhibited for different velocities of the α-particles.

When we consider the enormous forces between the nuclei, it is not so much a matter of surprise that the nuclei should be deformed as that the structure of the α-particle or helium nucleus escapes disruption into its constituent parts. Such an effect has been carefully looked for, but so far no definite evidence of such a disintegration has been observed. If this is the case, the helium nucleus must be a very stable structure to stand the strain of the gigantic forces involved in a close collision.

We have seen that the recoil atoms of all elements of atomic mass less than 18 should travel beyond the range of the α-particle, provided they carry a single charge. Preliminary experiments, in which the α-particles passed through pure helium, showed that no long-range recoil atoms were present, indicating that after recoil the helium atom carries a double charge. In a similar way no certain evidence has been obtained of long-range recoil atoms from lithium, boron, or beryllium. It is difficult in experiments with solids or solid compounds to be sure of the absence of hydrogen or water-vapour, which results in the production of numerous swift H atoms. These difficulties are not present in the case of nitrogen and oxygen, and a special examination has been made of recoil atoms in these gases. Bright scintillations were observed in both these gases about 2 cm. beyond the range of the α-particle. These scintillations are, presumably, due to swift N and O atoms carrying a single charge, for the ranges observed are about those to be expected for such atoms. The scintillations due to recoil atoms of N and O are much brighter than H scintillations, although the actual energy of the flying atom is greater in the latter case. This difference in brightness is probably connected with the much weaker ionisation per unit of path due to the swifter H atom.

The corresponding range of the recoil atoms was about the same in oxygen, nitrogen, and carbon dioxide. Theoretically, it is to be anticipated that the N recoil atom should give a somewhat greater range than the O atom. The recoil atoms observed in carbon dioxide are apparently due to oxygen, for if the carbon atoms carried a single charge they should be detected beyond the range of O atoms.

The number of recoil atoms in nitrogen and oxygen and their absorption indicate that these atoms, like H atoms, are shot forward mainly in the direction of the α-particles. It is clear from the results that the nuclei of the atoms under consideration cannot be regarded as point charges for distances of the order of the diameter of the electron. Taking into account the close similarity of the effects produced in hydrogen and oxygen, and the greater repulsive forces between the nuclei in the latter case, it seems probable that the abnormal forces in the case of oxygen manifest themselves at about twice the distance observed in the case of hydrogen, *i.e.* for distances less than $7 \times 10^{-13}$ cm. Such a conclusion is to be anticipated on general grounds, for presumably the oxygen nucleus is more complex and has larger dimensions than that of helium.

In his preliminary experiments Marsden observed that the active source always gives rise to a number of scintillations on a zinc sulphide screen far beyond the range of the α-particle. I have always found these natural scintillations present in the sources of radiation employed. The swift atoms producing these scintillations are deflected in a magnetic field, and have about the same range and energy as the swift H atoms produced by the passage of α-particles through hydrogen. The number of these natural scintillations is usually small, and it is very difficult to decide definitely whether such atoms arise from the disintegration of the active matter or are due to the action of the α-particles on hydrogen occluded in the source.

These natural scintillations were studied by placing the source in a closed box exhausted of air about

3 cm. from an opening in the end covered by a sheet of silver of thickness sufficient to stop the α-rays completely. The zinc sulphide screen was fixed outside close to the silver plate. On introducing dried oxygen or carbon dioxide into the vessel, the number of scintillations fell off in amount corresponding with the stopping power of the column of gas. An unexpected effect was, however, noticed on introducing dried air from the room. Instead of diminishing, the number of scintillations was increased, and for an absorption equivalent to 19 cm. of air the number was about twice that observed when the air was exhausted. It was clear from these results that the α-particles in their passage through air gave rise to long-range scintillations which appeared of about the same brightness as H scintillations. This effect in air was traced to the presence of nitrogen, for it was shown in dry, chemically prepared nitrogen as well as in air. The number of scintillations was much too large to be accounted for by the presence of traces of hydrogen or water-vapour, for the effect observed was equivalent to the number of H atoms produced by the mixture of hydrogen at 6 cm. pressure with oxygen. The measurements were always made well outside the range of the recoil nitrogen and oxygen atoms, which we have seen are stopped by 9 cm. of air.

These swift atoms which arise from nitrogen have about the same brightness and range as the H atoms produced from hydrogen, and, presumably, are charged hydrogen atoms. Definite information on this point should be obtained by measuring the deflection of a pencil of these atoms in a magnetic and electric field. The experiments are, however, exceedingly difficult on account of the very small number of the scintillations to be expected under the experimental conditions. It should be mentioned that the evidence so far obtained is not sufficient to distinguish definitely whether these are H atoms or atoms of mass 2, 3, or 4, for the range and brightness of the latter would not be very different from those shown by the H atom.

It is difficult to avoid the conclusion that these long-range atoms arising from the collision of α-particles with nitrogen are not nitrogen atoms, but probably charged atoms of hydrogen or atoms of mass 2. If this be the case, we must conclude that the nitrogen atom is disintegrated under the intense forces developed in a close collision with swift α-particles, and that the atom liberated formed a constituent part of the nitrogen nucleus. It may be significant that from radio-active data we should expect the nitrogen nucleus of atomic mass 14 to consist of three helium nuclei of mass 4, and either two hydrogen nuclei or one nucleus of mass 2.

The effect observed in nitrogen would be accounted for if the H nuclei were outriders of the main nucleus of mass 12. The close approach of the α-particle leads to the disruption of its bond with the central nucleus, and under favourable conditions the H atom would acquire a high velocity and be shot forward like a free hydrogen atom. Taking into account the great energy of the particle, the close collision of an α-particle with a light atom seems to be the most likely agency to promote its disruption. Considering the enormous intensity of the forces brought into play in such collisions, it is not so much a matter of remark that the nitrogen atom should suffer disintegration as that the α-particle itself escapes disruption. The results, as a whole, suggest that if α-particles or similar projectiles of still greater energy were available for experiment, we might expect to break down the nucleus structure of many of the lighter atoms.

## *UNIVERSITY AND EDUCATIONAL INTELLIGENCE.*

CAMBRIDGE.—Sir J. J. Thomson, Master of Trinity, who recently resigned the Cavendish professorship of experimental physics, has been elected into the newly established professorship of physics. This professorship is without stipend, and will terminate with the tenure of office of the first professor unless the University determines otherwise.

The General Board of Studies has made the following appointments:—Mr. F. W. Dootson, of Trinity Hall, University lecturer in chemistry; Mr. W. H. Mills, fellow of Jesus College, University lecturer in organic chemistry; Mr. R. Whiddington, fellow of St. John's College, University lecturer in experimental physics; and Mr. S. Lees, late fellow of St. John's College, University lecturer in thermodynamics.

EDINBURGH.—On the recommendation of the Secretary for Scotland, the King has appointed Sir Harold H. Styles to the chair of clinical surgery.

The following appointments by the University Court have been announced:—Dr. Meakin, McGill University, to the new chair of therapeutics; Dr. F. D. Boyd to the Moncrieff-Arnott chair of clinical medicine, vacant through the resignation of Prof. Russell; and Mr. T. P. Laird, lecturer in accounting and business method, to become professor when the ordinance for the new chair is approved.

The Court has also resolved to proceed with additional buildings for anatomy, and has approved the plans for a new chemical laboratory.

LEEDS.—The University Council has appointed to the chair of education Dr. John Strong, Rector of the Royal High School, Edinburgh, since 1914.

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PROF. T. BRAILSFORD ROBERTSON, formerly professor of biochemistry in the University of Toronto, has been appointed to succeed the late Sir Edward C. Stirling as professor of physiology in the University of Adelaide, South Australia.

THE Encænial proceedings of the University of New Brunswick in Fredericton, the capital, took place in May last. They included the *alumni* oration delivered by Prof. D. Fraser Harris, of the Dalhousie University, Halifax, N.S., who took for his subject "Science and Character-building." Prof. Harris laid stress upon the claims of science as giving a mental training second to no other intellectual exercise. He defined science as that training of the mind which is imparted by a rigorous, unbiased, and sympatheic study of Nature, demanding for its successful pursuit patience, care, exactness, and a strict reverence for truth, all of which qualities are essential to the building up of character, which is something more than being conventionally moral, since weak people can be moral and some conventionally immoral people have been strong characters—for instance, Cæsar, Nelson, and Napoleon. Character is strong without being oppressive, just without being narrow, self-reliant without being self-centred. Science produces heroism in her workers and has had her martyrs, some of whom were enumerated. Truth is what men of character search for, reverence, and seek to declare, and Prof. Harris gave a list of the great men of science who were conspicuous in this regard, strangely omitting the names of Darwin, Tyndall, and Huxley, and naively asked whether it is possible to name an equal number of men as eminent and as reverent in literature, philosophy, or art. Prof. Harris would have gained much had he carefully studied the close reasoning and the method of treatment of his subject displayed in the address of Huxley on "A Liberal Education and Where to Find It," delivered in the South London Working Men's College in 1868.

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## SOCIETIES AND ACADEMIES.

### SHEFFIELD.

**Society of Glass Technology**, June 18.—Mr. S. N. Jenkinson, president, in the chair.—S. N. **Jenkinson**: Impressions of a recent tour of the German glass factories. During a tour in Germany Mr. Jenkinson visited Silesia, Saxony, Saxe-Weimar, and other districts, and investigated conditions in several works, particularly glass factories. The size of the glass industry in Germany in pre-war days can be judged from the fact that in 1913 they exported glass to the value of 123,000,000 marks, and pottery to the value of 94,000,000 marks. This amount means that 75 per cent. of their output was exported. It can be realised, therefore, that the outbreak of war caused the shutting down of many German glass factories during 1914–15. The policy during 1915–16 in Germany was to re-open several of the factories and allow one furnace in each works to be kept going, and a scheme was inaugurated whereby finance in the industry was pooled. At the present time very little production of glassware is taking place, due largely to the lack of coal and the state of transport. All the plant in the works was kept in the highest pitch of efficiency, so that immediately opportunity came a high rate of production would follow. Out of some 132 furnaces into which Mr. Jenkinson made inquiries, only eight were working.—Dr. M. W. **Travers**: Some experiments with a gas-fired pot-furnace. The author gave a description of furnaces which had been used in producing chemical glassware, and advocated burning the gas from the producers in front of the pots, and taking the burnt gases out of the furnace at the back.—Edith **Firth**, F. W. **Holden**, and Dr. W. E. S. **Turner**: The properties of British fire-clays suitable for glassworks use. Part i.: The variation of shrinkage, density, and porosity with temperature. (Preliminary communication.) This paper was illustrated by assemblies of fire-clay blocks showing the behaviour of various fire-clays under the tests outlined by the authors. It is the first communication of a research carried out under the auspices of the Refractories Research Committee of the society.—A. V. **Elsden**, O. **Roberts**, and H. S. **Jones**: The examination of optical glass in relation to weathering properties.

### PARIS.

**Academy of Sciences**, June 23.—M. Léon Guignard in the chair.—A. **Lacroix** and M. **Tilho**: The volcanoes of Tibesti.—G. **Humbert**: The positive quadratic forms of Hermite.—A. **Rateau**: The theory of aeroplanes. Principal consequences of the formulæ. A development of a theory outlined in a previous communication.—R. **de Forcrand** and F. **Taboury**: The sulphones formed by sodium, rubidium, and cæsium iodides. The pressures of liquid $SO_2$ in contact with NaI, CsI, and RbI at $-23.5°$, $0°$, and $9.5°$ were measured, and compared with the pressures of liquid $SO_2$ alone at the same temperatures. The combinations $NaI+3SO_2$, $RbI+3SO_2$, and $CsI+3SO_4$ were isolated and analysed.—C. **Sauvageau** and L. **Moreau**: Marine algæ as food for horses. *Fucus serratus* and *Laminaria flexicaulis* form good food for horses, the only fault being that at the commencement there may be some difficulty in getting the animals to take them, and there is also a preliminary period during which digestion is incomplete.—M. Widal was elected a member of the section of medicine in succession to the late M. Dastre.—A. **Egnell**: Vectorial fields with indeterminate asymptotic directions.—G. **Rémoundos**: Singularities of differential equations and series capable of summation.—J. **Andrade**: A new method for the experimental study of flat spirals.—L. **Bloch**: The formula of Ritz and the theory of quanta.—H. **Colin** and Mlle. A. **Chaudun**: The law of action of sucrase. Influence of the viscosity on the velocity of hydrolysis. It has been shown in an earlier communication that after the ratio of saccharose to sucrase reaches a certain limit, the velocity of hydrolysis ceases to increase with the proportion of sugar; but for a considerable increase in the sugar concentration above this limit the velocity diminishes, and this is now shown to be due to the increased viscosity. The velocity of hydrolysis under these conditions is a linear function of the fluidity of the solution.—A. **Valeur** and E. **Luce**: The action of hydrogen peroxide upon sparteine and isosparteine.—C. **Gorceix**: The proof of an isostasic post-Glacial movement in the region of Chambéry. Age of the Voglans lignites.—J. **Rouch**: The velocity of the wind in the stratosphere. Observations on the coast, under conditions of clear sky and with moderate wind, show no reduction of velocity in the stratosphere.—J. **Tissot**: Mechanism of the destruction in the serum of the antigen sensitised cell by its specific antibody.—G. **Bertrand**: The mechanism of the preservation of fruit in cold water.

June 30.—M. Léon Guignard in the chair.—P. **Termier**: Transport phenomena of Alpine age in the Rhone Valley, near Avignon.—A. **Rateau**: Theory of the rectilinear rising of aeroplanes. The maximum ascension velocity.—G. **Charpy** and G. **Decorps**: The conditions of formation of coke. A continuation of previous communications by MM. Charpy and Godchot. Since the strength of the coke may vary with the preliminary compression of the charge and with the temperature of the retort, experiments are described in which the effect of change in each of these two variables was studied separately. The effect of a preliminary baking at a low temperature, 500° C., for forty minutes, followed by coking at 900° C., was also studied with interesting results, cokes with very high resistance to crushing being obtained by this means.—M. Andoyer was elected a member of the section of astronomy in succession to the late M. Ch. Wolf.—P. **Boutroux**: A family of multiform functions, integrals of a differential equation of the first order.—G. **Guillaumin**: Forced conduits with variable characteristic.—M. **Létang**: The phenomena which take place during the combustion of powder in a closed vessel.—A. **Cornu-Thénard**: Flexion tests of notched bars by shock.—M. **Brillouin**: The dynamical theory of the atom and the quanta theory.—L. **Benoist**: New porous walls filtering unsymmetrically. A complex filtering plate, consisting of three layers of different porosity, was constructed, the magnitudes of the porosities being 0·30, 0·23, and 0·18. The time of flow of a fixed volume of water under a given pressure was measured and found to vary with the direction of flow, according as it entered the most porous or least porous side of the plate.—H. **Abraham** and E. **Bloch**: Amplifiers for continuous currents and for currents of very low frequency.—G. **Chavanne** and L. J. **Simon**: The preparation of some volatile saturated cyclic or open-chain hydrocarbons contained in petrol.—A. **Guébhard**: Causes of displacement of the earth's crust.—S. **Stefanescu**: The practical application of the characters of the root of the molars of elephants and mastodons.—G. **Guilbert**: The prediction of variations of atmospheric pressure of small amplitude.—P. **Girard**: Physical scheme for the study of mineral nutrition of the cell.—A. **Besredka**:

Mechanism of typhoid infection in the rabbit. Anti-typhoid vaccination by the mouth.—A. C. **Hollande**: Pathogenic yeast forms observed in the blood of *Caloptenus italicus*.—J. **Dufrenoy**: The parasitic diseases of *Cnethocampa pityocampa* of Arachon pines.—MM. **Yamanouchi, Iwashima**, and **Sakakami**: Study of the influenza epidemic of 1918–19. Experiments on fifty-two voluntary subjects proved that the virus is filterable, and is found both in the sputum and in the blood of infected persons.

SYDNEY.

**Linnean Society of New South Wales**, March 26.—Mr. J. J. Fletcher, president, in the chair.—F. H. **Taylor**: Australian Tabanidæ, No. iv. One new genus is proposed in the subfamily Tabaninæ, and twenty-six species and one variety, referable to the genera Silvius, Cydistomyia, and Tabanus, are described as new.—T. **Steel**: The external parasites of the dingo (*Canis dingo*, Blum.). The occurrence of two fleas (*Ctenocephalus felis* and *C. canis*), a larval tick (near *Ixodes holocyclus*), and a louse (*Trichodectus latus*, or nearly related species) is recorded from a full-grown, pure-bred male dingo.—Dr. R. **Greig-Smith**: The germicidal activity of the eucalyptus oils, part i. When a serum-suspension of *M. aureus* was absorbed in cotton and placed in dilutions of the eucalyptus oils in olive oil for two hours at 20° C., it was found that the bactericidal power was proportional to the acidity of the oils. The germicidal effect was not caused by the acidity, but was assisted by it. The effect upon *B. coli communis* was of much the same nature, although the action of the acid was not so clearly shown. The iodide reaction was no criterion as to the germicidal value of the oils. The vapours of the oils had a decided bactericidal action.

April 30.—Mr. J. J. Fletcher, president, in the chair.—Dr. R. J. **Tillyard**: The morphology and systematic position of the family Micropterygidæ (sens. lat.). Introduction and part i.: The wings. This family of archaic, moth-like insects has been regarded as belonging to the order Lepidoptera until quite recently, when Dr. T. A. Chapman, on one hand, removed the genus Micropteryx alone to a new order Zeugloptera, retaining Eriocrania and its allies in the Lepidoptera, while, on the other, Prof. Comstock has removed the whole family bodily into the Trichoptera. The object of the paper was to elucidate the morphology of the group and to determine its correct ordinal position within the Insecta.—A. H. S. **Lucas**: Notes on Australian marine Algæ. No. ii. Descriptions of four new species.—Dr. A. B. **Walkom**: A collection of Jurassic plants from Bexhill, near Lismore, N.S.W. The known flora of the Clarence series in northern New South Wales is increased from four species to eleven, the additions indicating conclusively that the portion of the series from which they were obtained is of Jurassic age. This flora shows a closer resemblance to the Jurassic flora of Victoria than to any other Australian flora of similar age.

## *BOOKS RECEIVED.*

Four-Place Logarithmic and Trigonometric Tables, together with Interest Tables. Edited by Prof. Louis C. Karpinski. Pp. 30. (Michigan: George Wahr, 1918.) 30 cents.

La Théorie Atomique. By Sir J. J. Thomson. Pp. vi+57. (Paris: Gauthier-Villars et Cie, 1919.) 2.40 francs net.

Géodésie Topométrique. Troisième Fascicule. Détermination du Point par Relèvement. Méthode du Service Hydrographique de la Marine Dite du "Point Approche." By Emile Balu. Pp. vi+57+2 plates. (Paris: Gauthier-Villars et Cie, 1919.) 6 francs net.

Introduction à la Chimie Générale. Lois Fondamentales de l'Atomisme et de l'Affinité Exposées à des Chimistes Débutants. By Prof. H. Copaux. Pp. vi+212. (Paris: Gauthier-Villars et Cie, 1919.) 7.50 francs net.

The Urethroscope in the Diagnosis and Treatment of Urethritis. By Major N. P. L. Lumb. Pp. xii+51+10 plates. (London: John Bale, Sons, and Danielsson, Ltd., 1919.) 10*s*. 6*d*. net.

Annual Reports on the Progress of Chemistry for 1918. Issued by the Chemical Society. Vol. xv. (London: Gurney and Jackson, 1919.) 4*s*. 6*d*. net.

Science and War: The Rede Lecture, 1919. By the Right Hon. Lord Moulton. Pp. 59. (Cambridge: At the University Press, 1919.) 2*s*. 6*d*. net.

Smithsonian Institution: Bureau of American Ethnology. Bulletin 59. Kutenai Tales. By Franz Boas. Together with Texts collected by Alexander Francis Chamberlain. Pp. xii+387. (Washington: Government Printing Office, 1918.)

Senior Practical Chemistry. By H. W. Bausor. Pp. viii+217. (London: W. B. Clive, University Tutorial Press, Ltd., 1919.) 3*s*. 6*d*.

A Dictionary of the Flowering Plants and Ferns. By Dr. J. C. Willis. Fourth edition, revised and re-written. (Cambridge Biological Series.) Pp. xii+712+lv. (Cambridge: At the University Press, 1919.) 20*s*. net.

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