SATURDAY, OCTOBER 22, 1927.

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Editorial and Publishing Offices :
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

Science and Philosophy.

THE mild controversies which have been excited by Sir Arthur Keith's moderate and cautious presidential address to the British Association at Leeds suggest that science and scientific method are still regarded with some suspicion by the educated portion of the community. We need not take seriously the objections to the theory of evolution raised on sentimental or religious grounds in so far as these arise from prejudice and belief in authority. Science can recognise no authority, and can admit no barrier to the free and fearless use of the intelligence. The theory of evolution stands or falls on the "stubborn and irreducible facts" and upon the rational interpretation of them, and we need have no fear of the verdict of any impartial and competent jury, as Sir Arthur Keith has well and truly pointed out.

Another note has, however, been sounded by the wiser critics—a note not so much of antagonism as of doubt whether scientific method has, after all, proved an adequate key to the problems of the universe and of practical life. The Bishop of Ripon has voiced with great frankness this doubt of the adequacy of science. In hinting that the world could get on perfectly well if for ten years every physical and chemical laboratory were closed, he had in mind apparently two things—first, that the progress of science has vastly increased the complexity of man's material environment without improving his moral outlook or adding to his happiness, and second, that not only educated laymen but also specialists themselves are so overwhelmed with the rush of new discoveries, new conceptions, that they have no time to envisage the results as a whole, to co-ordinate them and see them in their proper relation to other human activities. He suggested in reference to the first point that the "patient and resourceful energy" displayed in the laboratories could be turned to better effect if it were applied to the human and social problems of the day, where clear and resolute thinking is so much required. With this contention we do not propose to deal. *Ne sutor supra crepidam* is a sound, if unheroic, maxim.

It is rather with the second point that we wish to come to grips, and particularly with the suggestion—emphasised also by several writers in the *Times*—that science is suffering from neglect of philosophy, to its own detriment and to the lessening of its influence on human thought and character. Dr. Burroughs, in the sermon referred to, asked whether amid all our new discoveries we do not sometimes seem to have lost our sense of direction: "How many of our sectional explorers ever ask themselves which way lies the whole? Am I wrong in thinking that the several sciences increasingly feel the need of a philosophy to co-ordinate them?"

Twenty or thirty years ago, this suggestion that science might learn from philosophy would have been received with scorn in scientific circles. There was a spirit of confidence abroad, a conviction that the principles which had served so well and had led to such conquest over Nature were established beyond question; philosophy was branded as metaphysical and dealing in vain abstractions. We find an echo of this great period in Dr. Chalmers Mitchell's provocative and vigorous Huxley Lecture,[1] where he roundly asserts that "philosophy, since she was judicially separated from science, although retaining the title 'lover of wisdom,' has made no positive addition to knowledge and has only been a spinner of vain words and barren ideas." This intransigent attitude is, we venture to think, rather unusual at the present day. The last twenty years have seen the foundations of physics torn up and rebuilt, and the change has come about not only by the press of new knowledge, but also to a great degree through keen hard thinking about the fundamental conceptions of the science, through true philosophical criticism, carried out by the physicists and mathematicians themselves. We can no longer rest content with the simple materialistic schema which satisfied Descartes and Laplace. As Prof. A. N. Whitehead writes in his remarkable book, "Science and the Modern World":

> "The progress of science has now reached a turning point. The stable foundations of physics have broken up. . . . The old foundations of scientific thought are becoming unintelligible. Time, space, matter, material, ether, electricity, mechanism, organism, configuration, structure, pattern, function, all require reinterpretation. What is the sense of talking about a mechanical explanation when you do not know what you mean by mechanics?"

Yet Dr. Mitchell would have us cling tenaciously to the mechanistic method in biology, on the ground that only through its aid has come any positive increase of knowledge. This is not the occasion to discuss in detail the merits and the shortcomings of the mechanistic method in biology; we may, however, remark *à propos* of Dr. Mitchell's lecture, that his polemic against 'vitalism' mostly misses the mark, for the alternative to biological materialism is not necessarily a dualistic vitalism, but some form of organismal or emergent theory, all of which he confounds under the common ban.

The mechanistic method, however, is itself an interpretation of Nature. It is, to use Dr. Mitchell's own words about vitalism, "a proclamation of a belief and not an inference from observation." Its sole justification is the practical one, that it does up to a point help us to understand the activities of living things. But there are other methods of explanation possible, and it is unwise to rule them out as unscientific. Since physics has found a revolution in its fundamental concepts necessary, it seems dangerous for biology to cling to the cast-off beliefs of the nineteenth century physicists. It must come to terms, too, with psychology, and give up the hopeless attempt to derive conscious behaviour from tropisms and conditioned reflexes, regarded as purely physical happenings.

The time is indeed ripe for a critical revision of biological concepts. We need not fear that this will lead us into mystical by-ways. It is probable that there will always be something left unexplained—even Dr. Mitchell doubts the possibility of the part interpreting the whole—but clear thinking not only about the facts of observation, but also, more important still, about our own methods of interpretation, will help to reduce and render manageable the mysteries of organic life and evolution.

Shall we call this criticism of conceptions science or philosophy? This brings us to the heart of the matter, and to our tentative conclusion, which is that the nineteenth century divorce of science from philosophy is good for neither side, and that co-operation should now be the order of the day. The benefit will be mutual. There has been some justification for the jibe that philosophy deals with words and abstractions, and is apt to be neglectful of the laboriously garnered harvest of scientific fact. In the recent discoveries both in physical and in biological science, there is ample material to keep the philosopher busy for years. The man of science for his part can learn much from the philosopher. He can learn how biassed and provisional his views of Nature may be, how difficult it is to get rid of irrational presuppositions which may colour all his thought.

In his eloquent tribute to Huxley, Dr. Mitchell points out that

> "He accepted, as a postulate, but admitting it to be a postulate, belief in the rationality of the universe our minds seek to explore. This was the charter of science, conferring a certain right in

[1] "Logic and Law in Biology." Huxley Memorial Lecture, 1927. Pp. 30. (London: Macmillan and Co., Ltd., 1927.) 1s. net.

return for the observance of certain duties. The right was that the writ of science should run whatsoever traditions, beliefs, dogmas, or customs it might destroy. The duties were accurate observation, clear statement, a logical scrutiny of generalisations so that they should not imply and should not seem to imply an iota of necessity; an open mind for new facts, but a cross-examination of the evidence for them the more ruthless in proportion to their apparent contradiction of widely based generalisations: and above all a profession of ignorance in preference to the propounding of acceptance of 'causal' principles which could not be put to the test of experiment."

That is well said, but it does not go far enough. Let the clear thinking and the logical scrutiny be applied not merely to the generalisations resulting from observation and experiment but also to the underlying conceptions, the basal philosophies, in accordance with which these generalisations are formed. Let us scrutinise everything—even our most cherished scientific principles.

Coming back now to the broader question of the relation of science to other forms of human activity, we must recognise the limitations of scientific and indeed of any purely intellectual method. There are other aspects of human personality which science does not satisfy, and it would be foolish to extend the dominion of scientific method beyond its proper sphere. We do well to remember that the richness of reality is inexhaustible, both in its manifestation in the external world and in the depths and recesses of personality. Neither science nor philosophy can give more than an abstract and colourless rendering of essential truth, which is approached perhaps most nearly by creative art. But inside these necessary limitations the exercise of the intellect should be free, fearless, and untrammelled by any dogmatism, prejudice, or dependence on unrealised assumptions.

Brewing and Malting.

A Standard Manual of Brewing and Malting and Laboratory Companion. Being a thoroughly revised and considerably augmented work, based on "A Handy Book for Brewers," by H. E. Wright, embracing the Conclusions of Modern Research. By John Ross-Mackenzie. Pp. xxiii+415. (London: Crosby Lockwood and Son, 1927.) 45*s*. net.

As a result of the great change which has taken place in recent times in the nature of the beer favoured by the public, the demands on the skill of the modern brewer are much more exacting than they were on that of his predecessor of a generation ago. The brilliant and well-conditioned beer of to-day is characterised from the brewer's point of view by a low original-gravity, low alcohol-content, and low hop-rate. These factors, combined with the lack of nutrient matter in the modern wort, place a greater strain on the yeast, and also render the beer more liable to infection. On the other hand, modern scientific methods have provided a weapon with which to combat these difficulties. These are the influences traceable throughout the volume under review, and mark a stage in the passage of brewing from an art to a science.

The book appeared in its original form so far back as 1877, and was intended at that time essentially for the novice. In 1892 it was revised and enlarged under the title "A Handy Book for Brewers," but the author, H. E. Wright, died at the time of the publication of the third edition in 1907. In the twenty years that have since elapsed the information has naturally become out-of-date, and the appearance of a revised and augmented work is to be welcomed. The plan and scope of the last edition has been followed fairly closely, though the student rather than the brewer is catered for.

The first chapter sketches in outline the complete brewing process, and should prove useful to the beginner if studied in conjunction with the synoptic table at the end of the book, since the brewing operations are dealt with in order in more detail in the subsequent chapters. Brewing-room calculations, chemistry, hydrogen ion concentration and ferments in general provide additional chapters, and the book closes with a brief, elementary description of the brewery and its plant.

In a book which attempts to cover so vast a subject and its ramifications, in which the details of the methods used are largely matters of personal opinion based on experience, it is not difficult to pick out omissions and errors. On controversial points, however, the author has apparently endeavoured to strike a balance between opponents and to produce an argument that is not too bewildering for the beginner. This has involved the omission of a great deal of the most recent investigations on subjects such as starch, yeast, and the preservative powers of hops, though a readable account is given of the earlier work. Again, for example, reference might with advantage have been made to the vexed question of the Mariout barley, which in spite of its favourable analysis, appearance, and powers of resistance to extremes of climate, has been condemned in many quarters. The disposal of brewery by-products is also of sufficient economic importance to justify its inclusion.

The author is at his best when he deals with the varying conditions which influence the practical side of brewing. His descriptions of chemical operations, however, are often lacking or out-of-date. We doubt whether the student will be able to obtain the required degree of accuracy from many of the instructions with which he is provided, especially if his intelligence is assumed to be of such a level that he has to be told which end of the thermometer to insert in the drying-oven! A redeeming feature of the descriptions of the applications of science to brewing is the chapter on hydrogen ion concentration, the theory of which is outlined clearly by F. A. Mason. Its usefulness, however, will be largely obviated by the fact that the practical applications of the theory occupy only half a page of this chapter, and nowhere else in the book are they mentioned. This is a serious drawback when subjects such as mash-tun treatment, stability of beer, and the optimum conditions for enzymes are under discussion.

It is unfortunate that the book is characterised throughout by an extremely loose form of grammatical expression which at times renders the meaning almost unintelligible. Minor errors and misprints are far too numerous also, and the spelling of many words is rendered correctly in some parts and differently or incorrectly in others. Proper names (Buchner, Marsh-Berzelius, etc.), and the title of Pasteur's classical work on beer, are among the more serious offences in this last respect. There is a lack of references to the original literature, and the frequent mention of a glossary which had to be omitted at the last moment is confusing. There is also a paucity of illustrations, the few given being chiefly photographs of plant. The briefest description of the anatomy of the barley-corn, or of the hop, is incomplete without a diagram.

The book is well produced, but the advertisements, which have invaded even the end-papers and the backs of the title and contents pages, are an eyesore. J. G.

Plant Diseases.

Manual of Plant Diseases. By Dr. F. Deforest Heald. (McGraw-Hill Publications in the Agricultural and Botanical Sciences.) Pp. xiii + 891. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1927.) 35*s*. net.

THIS important book is the result of considerable experience in the teaching of plant pathology, which is now a recognised feature of agricultural and horticultural training. The arrangement and treatment of the subject matter follows that adopted by Dugger in his well-known "Fungous Diseases of Plants," and has been used by the author in his classes during the last ten years. The book is divided into four sections, the first containing two chapters dealing respectively with the history of pathology and the symptoms of disease; the latter especially should be read by all students of the subject. Section 2 deals with non-parasitic diseases, caused by some unfavourable influence in the plant's environment. The effects of excess and deficiency of available nitrogen and potash in the soil are discussed at length, and examples are drawn from 'sand drown' of tobacco, 'yellow berry' of wheat, and 'potash hunger' of potatoes and tobacco. It is perhaps unfortunate that the important problem of 'leaf scorch' of orchard trees finds no place in the discussion. A considerable amount of useful information is given in other chapters setting out the effects of unfavourable air, light, temperature, and water conditions upon plant growth. 'Bitter pit' and 'scald' of apples are excellent examples of the treatment given to individual disorders.

The phenomenon of photoperiodism, which has attracted much recent attention, is briefly described in three pages. One may perhaps doubt the advisability of including it in such a book, where space is valuable, but if it is worth discussing at all in relation to plant disease, these pages seem quite inadequate for the purpose.

In dealing with diseases proper, the author has selected those which are of economic importance, and has described the history, distribution, symptoms, etiology, host relations, and control of each, together with a list of references at the end of each disease and a brief note of etiologically related diseases at the end of each chapter. The lists of references to literature are extensive, but they are mainly concerned with American investigations. Reference to foreign papers seems desirable.

Section 3 is devoted to virus and related diseases. Only those who have struggled with the mass of literature on this subject can appreciate Dr. Heald's difficulty in compiling a reasoned account of these fascinating diseases. He has succeeded in giving the elementary student an insight into the subject, which should stimulate his interest and appreciation of its importance.

Section 4 occupies two-thirds of the book, and is devoted to parasitic diseases, including those caused by bacterial pathogens, which are classified in accordance with Migula's scheme. *Actinomyces scabies* is, however, included among the bacteria. Fungus diseases are treated admirably, with good arrangement and up-to-date material. Students should have little difficulty in obtaining a good working knowledge of plant diseases. The section ends with a discussion of diseases caused by parasitic seed plants and nematodes, but the latter chapter does bare credit to the importance of these animal pests. Investigators have the greatest difficulty in distinguishing between parasitic and non-parasitic forms present in diseased material, and many harmless forms have been convicted of evil intent without proper trial. Students should be warned against this.

A good general index is provided, but there is no host index. The volume is well illustrated, and the illustrations are usually effective, but Figs. 199-202 are decidedly poor and are not calculated to inspire the student.

The object of teaching plant pathology is to train workers to diagnose and control diseases which are causing serious damage to economic plants the world over. This being so, an effective text-book must include a clear account of the physiology of disease and the principles of disease control. It is regrettable that Dr. Heald has purposely omitted this part of the teaching of pathology from his text-book, which will doubtless be used by many teachers of the subject.

W. F. B.

A New Version of the 'Intellect.'

The Measurement of Intelligence. By Edward L. Thorndike, E. O. Bregman, M. V. Cobb, Ella Woodyard, and the Staff of the Division of Psychology of the Institute of Educational Research of Teachers' College, Columbia University. Pp. xxvi + 616. (New York: Teachers' College, Columbia University, n.d.) n.p.

MANY circumstances invest the present volume with signal importance. Of such an unusual magnitude has been deemed the investigation which it reports, that a special grant was assigned to it by the Carnegie Corporation; and for the last four years Thorndike has so devoted himself to it, as even to give up for its sake his university teaching. Moreover, as indicated above, his entire staff has been collaborating with him.

The account of all this work begins by freely conceding that hitherto mental tests of the intellect have been afflicted with "three fundamental defects": ignorance of what is being tested; ignorance of how the test-scores should be combined; and ignorance of what the results signify in respect of the intellect.

To cope with this situation, the authors in the first place conceive the intellect as having two dimensions: on one hand "altitude"; on the other, "width." By the former they mean "the degree of difficulty at which a person can succeed at tasks"; by the latter, "the number of tasks that he can succeed with at any specified degree of difficulty."

So far, all is plain sailing enough. But now have to be encountered the "fundamental defects." For these concepts of altitude and width of intellect can serve no useful purpose until we settle what kinds of mental performance the word 'intellect' is really intended to comprise. On this vital point the authors commence in a surprising fashion.

"For a first approximation, let intellect be defined as that quality of mind (or brain, behavior, if one prefers) in respect to which Aristotle, Plato, Thucydides, and the like, differed most from Athenian idiots of their day."

How the mental make-up of these idiots shall ever be ascertained is left unsaid.

Later on, however, a more definite view is advanced and made the actual basis of the present investigation. It is to the effect that every one can take intellect to mean whatever he will.

"What abilities and tasks shall be treated as intellectual is essentially a matter of arbitrary assumption or choice at the outset. . . . After the first choice is made, tasks not included in it, and not even known, may be found to correlate perfectly with the adopted total, and so to be 'intellectual.'"

The authors themselves select as their "first choice" what they call "intellect CAVD," composed as follows.

"C. To supply words so as to make a statement true and sensible.
"A. To solve arithmetical problems.
"V. To understand single words.
"D. To understand connected discourse, as in oral directions or paragraph reading."

To the study of this "intellect CAVD," then, the whole investigation is really directed, and a very remarkable result is the outcome. Evidence is adduced that these four abilities, C, A, V, and D, jointly constitute one single "total-ability," in the sense of a "unified, coherent, fundamental fact in the world."

With great interest the reader turns to examine upon what sort of evidence such a result has been founded. It consists in the discovery that the different "altitudes" of the intellect CAVD correlate with one another to a degree which—on due correction for attenuation by random disturbances —is little if at all short of perfect unity. This line of evidence in respect of the originally adopted intellect CAVD is just the same, it will be noticed, as that which our previous quotation gives for making any subsequent additions to the purview.

Now comes a curious point which the authors appear to have overlooked. It is that this kind of evidence—perfect correlations after being corrected for attenuation—is precisely that which was introduced by the present reviewer in first demonstrating the existence of what our school calls *g*. Even the various criteria used afterwards for this purpose (including the latest, that of 'tetrad differences') are merely diversified mathematical forms of expressing exactly the same thing. (For proof of this statement, reference may be made to the reviewer's recent work, "The Abilities of Man.")

It only remains, then, for Thorndike to carry out his programme and ascertain what further abilities correlate perfectly with his initial CAVD, when the correction for attenuation is effected in a suitable manner. Assuredly he will find, just as we have done in the book just referred to, that the range includes all abilities whatever. In this way his "unified, coherent, fundamental fact in the world" turns out to be our *g* once again, nothing more or less.

Hereby is completed the entire chain by which, link after link, the school of Thorndike has been gradually adopting all the chief doctrines long advocated by ourselves. In such an eventful convergence of originally warring views, we may venture to see a most hopeful augury for the future of psychology as a positive science.

C. Spearman.

Tycho Brahe.

Tychonis Brahe Dani: Opera Omnia. Edidit I. L. E. Dreyer. Tomus 8. Pp. 471. n.p. Tomus 12. Pp. iv+488. n.p. Tomus 13. Pp. iv+398. n.p. (Hauniæ: Libraria Gyldendaliana, 1925–1926.)

The eighth volume of this monumental edition has the melancholy distinction of being the last that was published in the editor's lifetime. It shows no diminution of the accuracy which always distinguished Dr. Dreyer's work. The editor calls it the third volume of the "Epistolae Astronomicae," a series which is here continued from June 1597 to June 1601, four months before Tycho's death.

The plan of this volume is the same as that of the second volume of the "Epistolae," the seventh of the whole series, but the subject matter is largely different. While the second volume was mainly occupied by letters written while Tycho was steadily pursuing his observations at Hveen, supported by liberal emoluments and aided by numerous assistants and workmen, in this volume he is a traveller, seeking a new home in which to continue his work. We find him first at Rostock, then at Wandsbeck, afterwards at Benatky, and finally at Prague; and it is natural that his correspondence should be largely concerned with negotiations for reconciliation with his former patron the Danish king, or with the view of securing a new patron, such as he eventually found in the Emperor Rudolf II. We have also the correspondence relating to the equipment of the observatory at Benatky.

For the life of Tycho, these letters are most interesting. They have the further interest that they introduce us to Kepler, whose first letter to Tycho, accompanying a copy of his "Mysterium Cosmographicum," begins on p. 14 of the volume, and whose last letter in October 1600 ends on p. 385. As the connexion thus established with Kepler was the most important, it might be said the only valuable result of Tycho's removal from Denmark, and as it resulted in the discovery of the laws of planetary motion, it is very gratifying to find this correspondence set in its place among Tycho's astronomical letters.

The most interesting letters in this correspondence are perhaps Tycho's critique of the "Mysterium Cosmographicum" and the testimonial which Tycho gave Kepler in June 1600. Both have been published among the collected works of Kepler and are well known to students of the history of astronomy. In the former letter (pp. 44-46), Tycho, in the most courteous way, cast doubt on Kepler's theory of the connexion between the planetary spheres and the five regular solids, because it rested on Copernicus's values for the distances and eccentricities, which were seriously in error. He also objected to any doctrine of 'orbium realitas,' that is, to any reality of the spheres, and regarded the immense distance to which the Copernican hypothesis relegated the so-called eighth sphere, the sphere of the fixed stars, as an absurdity which by itself would destroy the whole theory. He suggested that Kepler should continue his line of study, including the eighth sphere in his harmony, and invited his co-operation. In the same letter Tycho declared that the reason for his removal from Denmark was to prevent the destruction of his astronomical treasury collected through so many years with such great labour and expense. With our great store of observations it is difficult to realise the uniqueness of Tycho's work, so far exceeding anything that had survived from the ancient or that seemed likely to be attempted again in the modern world.

The editor, in addition to his usual brief but pertinent comments, has in this volume given us an alphabetical biographical index of the principal people named in the astronomical letters.

The twelfth and thirteenth volumes complete the collection of Tycho's observations. A flysheet issued with the last of these and dated 1926, Sept. 25, records how Dr. Dreyer before his death on Sept. 14 had requested the presidents of the Society of Danish Language and Letters to present this last volume of Tycho Brahe's treasury of observations to the Carlsberg Institute on Sept. 25, the fiftieth anniversary of its foundation, in gratitude for the munificence with which it had provided for the publication of the greater part of the works of the famous Danish astronomer.

The two volumes of observations contain not only Tycho's observations, but also several by Fabricius, and a few collected by Kepler. There are also two catalogues of stars, but Tycho's complete catalogue appears elsewhere. Probably the most important part for present-day astronomy is to be found in the 107 pages devoted to observations of seven comets. These observations at least can never be superseded by observations of other comets made with better instruments.

J. K. F.

Our Bookshelf.

Artificial Fertilisers: their Chemistry, Manufacture and Application. By P. Parrish and A. Ogilvie. Vol. 1. Pp. 356. (London: Ernest Benn, Ltd., 1927.) 45*s.* net.

As the authors state in their preface, this is the first English treatise on artificial fertilisers which deals in any detail with the technique of the manufacture of fertilisers. This, the first of two volumes, is almost entirely devoted to the manufacture of phosphatic manures, and the mixing and compounding of these with other fertiliser ingredients. After surveying in some detail the world's resources of phosphatic material, the mining operations are described in some detail.

The bulk of the book is taken up with the manufacture of superphosphate, by-products of other industries such as basic slag taking quite logically a minor share. Superphosphate manufacture in its main outline has not changed since its invention, and improvements are due rather to engineering than to chemical progress, and modern plant and machinery are described and well illustrated by diagrams and photographs. The chemistry of the manufacture of soluble phosphates is dealt with briefly but adequately for the needs of the technician, although the statement on p. 31 that "phosphate rock is essentially tricalcium phosphate" is misleading and is contradicted later in the book. The chemistry of open-hearth basic slag is still obscure, but enough is said to indicate the problems before the investigator. A correct interpretation is given of the results in the citric solubility test for water-insoluble phosphate and, up to the present, no better measure of the availability of phosphate to the plant has been discovered.

This work comes at an opportune moment: the old-fashioned fertiliser industry in Great Britain has not only to face foreign competition in the export trade, but also attractive new compounds now being placed on the market by the great German fertiliser firms. In these, phosphoric acid functions as a carrier of ammonia and sometimes of potash also. The superphosphate manufacturers of Great Britain are fully alive to this new aspect and the formation of the International Superphosphate Association is the result. In a stimulating and thoughtful final chapter the trend of future developments is discussed. The authors conclude that superphosphate will be required for many years to come, but that only larger factories operating with highly efficient plant will be able to compete at all successfully.

Such a readable and well-illustrated book cannot fail to be of interest and service to all connected with the fertiliser trade, and the second volume will be awaited with interest.

The Practical Telephone Handbook and Guide to the Telephonic Exchange. By Joseph Poole, and others. Seventh edition, thoroughly revised and enlarged. Pp. xxv+870. (London: Sir Isaac Pitman and Sons, Ltd., 1927.) 18*s.* net.

During the last few years the art of telephony has made gigantic strides and the future of the telephone industry seems very promising. Many engineers first acquired their working knowledge of the subject from the earlier editions of this well-known handbook. It has gradually increased in size, although much obsolete and obsolescent matter has been cut out in each edition. In this latest edition the book has been increased by 146 pages and more than 100 illustrations. Although the book is becoming more technical and more mathematical, it can still be recommended for the beginner. The rapid progress of automatic telephony in Great Britain has taken even experts by surprise. A few years ago it used to be urged that its secrecy, which is really one of its greatest advantages, laid it open to the practical joker who could play silly tricks with impunity. In the United States the trouble had proved to be a real one, and special laws were proposed to frighten the jokers. An unscrupulous business man also might cause the line of a rival to test 'engaged' at important times of the day. Luckily these defects have been completely remedied.

To scientific men the use that telephonists make of 'phantom circuits' to increase the number of conversations that can take place simultaneously between two stations always seems wonderful. The authoritative account of trans-Atlantic telephony given in this book will prove helpful to many. The saving of costs of trunk lines by means of thermionic valve repeaters is shown by the fact that in place of aerial lines weighing from 100 lb. to 800 lb. per mile, there are now underground cables working between London and Glasgow and between London and Berlin weighing only about 20 lb. per mile.

Linienspektren und periodisches System der Elemente. Von Dr. Friedrich Hund. (Struktur der Materie in Einzeldarstellungen, herausgegeben von M. Born und J. Franck, Band 4.) Pp. vi + 221. (Berlin: Julius Springer, 1927.) 15 gold marks.

SINCE the work of Bohr, followed by that of Sommerfeld, Catalán, Heisenberg, and others, gave a theoretical foundation to spectroscopy, the analysis of the spectra of the elements on the basis of quantum mechanics has proceeded apace. The results are scattered through many journals, in many tongues. This material the author has collected and welded into a coherent account. The appropriate results of quantum analysis are quoted and their significance explained without the burden of mathematical proof. The application of these results to the line spectra of the elements of the different columns of the Periodic Table is then fully discussed. Practical spectroscopists, chemists, and (may we whisper it) students of physics who wish to learn something of the methods and results of the new spectrum analysis, without first undertaking the formidable task of learning quantum mechanics, will welcome this well-written and informative account. For those who may wish to pursue the subject further, either on its more theoretical or on its experimental side, the author supplies a full and well-arranged bibliography of the literature of the subject, to the end of the year 1926.

Thermodynamics and Chemistry. By Prof. F. H. Macdougall. Second edition. Pp. vii + 414. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1926.) 27*s.* 6*d.* net.

THE first edition of Prof. Macdougall's book was well received, and in the new edition the author has incorporated a considerable amount of new matter and has revised the old so that the work is considerably improved. The treatment is straightforward, with a free use of the calculus. The rather long section on phase rule diagrams is out of place, since there are separate text-books giving a better and more detailed treatment of this branch of the subject, which is more a matter for the drawing office than for the student of thermodynamics. The properties of electrolytes are dealt with from the point of view of activity, and the Debye equation is used, although its detailed deduction is omitted. A good feature is the inclusion of problems, but these are omitted in the last chapter on the quantum theory and Nernst's heat theorem. The number of books on chemical thermodynamics is not large, and Prof. Macdougall's is a useful member of the group. The only unsatisfactory feature of the book is its price, which is excessive, although that of the first edition was even higher.

South America: an Economic and Regional Geography; with an Historical Chapter. By Dr. E. W. Shanahan. (Methuen's Geographical Series.) Pp. xiv + 318. (London: Methuen and Co., Ltd., 1927.) 14*s.* net.

DR. SHANAHAN has succeeded in producing a book on South America that was much needed. After some preliminary chapters on the continent as a whole, including a most interesting one on historical geography, he treats South America by natural regions, thus avoiding much repetition which a treatment by States would entail.

The book bears evidence of wide and discriminating reading, but it gives the impression of a compilation and lacks signs of personal acquaintance with South America. Many of the broader human interests receive little notice, such as the immigration problems, the racial problems, and the character and peculiarities of the great cities and seaports. Cities are not merely market places; they have individualistics that are worthy of portrayal even in a geographical work, if geography is to escape the charge of being merely the background of commerce. But in spite of these criticisms we welcome the book, especially for its freedom from bias towards any particular interest or State, a defect which mars too many works on South America.

An Introduction to Building Science. By F. L. Brady. Pp. viii + 280. (London: Edward Arnold and Co., 1927.) 7*s.* 6*d.* net.

IN a series of twenty-five chapters the author discusses his subject under the headings of physics and chemistry. His method is perspicuous and the diagrams deserve appreciative notice, as also the series of experiments and the lists of questions at the end of the successive chapters. They serve the useful purpose of testing the degree of knowledge acquired from the previous pages.

The use of constants for conversion from one thermometric scale to another is most unnecessarily condemned by Mr. Brady. He is, of course, not responsible for the double significance of the word calorie (distinguishable only by the employment of upper or lower case initial), but such duplication is unfortunate. If it be granted that "alloys are mixtures of metals," why call steel an alloy? It is no more an alloy than is wrought or cast iron, all three being dependent upon the proportion of contained carbon. Fig. 37 would be better were the comparative diagrams drawn to one scale. The book is, however, one to be accorded a hearty welcome.

Letters to the Editor.

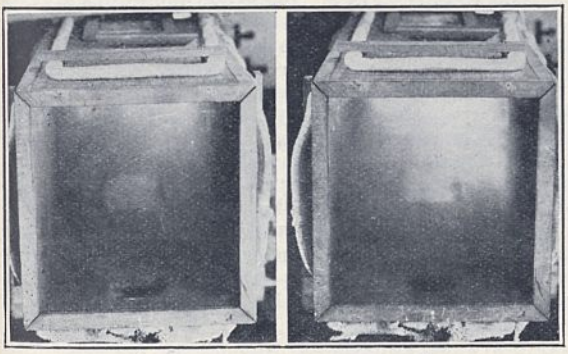
[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Magneto-optical Effect and a Correction.

THIS communication concerns the magneto-optical effect, described by me in *Science* (N.S. vol. 53, No. 1382, pp. 565 to 569, June 24, 1921) and NATURE, June 23, 1921, p. 520, which was at that time a novel discovery or observation. The description was later followed by a statement of "Further Investigations" (*Science*, N.S. vol. 54, No. 1387, pp. 84-85, July 29, 1921).

In the first place I desire to make a correction in the latter communications, where it is stated that the "flickering observed appears to keep time with the *cycles* and not with the *alternations* of current." This is an error, as it was found later that the described fluctuations do follow the alternations, the mistake being due to misinformation as to the cyclic rate.

It may be desirable here to describe briefly the original phenomena, adding comments which relate to more recently observed facts. A magnetic field produced by a direct current, permanent magnet, or by interruptions or alternations of current, is rendered visible even when very weak, by a light smoke from an iron arc; such fume or smoke being effective for the purpose even when so thin or diffused as to be scarcely noticeable in the air. Such smoke, diffused in the space where a field exists, when illuminated from above by sunlight or an artificial source and viewed in a direction across the light beam and more or less normal to the direction of the lines of force of the field, apparently becomes luminous, but in reality becomes a far better reflector diffuser in certain directions of the incident light than when the field lines are absent.



a FIG. 1. *b*

Viewed along the magnetic lines, no increased luminosity is produced even when the field is strong or the illumination strong, or both.

The condition for its observations seem to be :

(1) Illumination transverse (more or less) to the direction of the lines of the field.

(2) Viewing in a direction more or less transverse to the lines of the field and to the direction of the incident light.

The amount of iron smoke in the air required to produce a very noticeable effect seems to be very small, although density of the smoke increases greatly the contrast between what is visible when current or field is on, and when no field exists. Indeed, without the presence of the field the smoke from the iron arc may be practically invisible. The illumination from the smoke particles was found to be polarised as if produced by reflection from strings of fine particles, oriented in the direction of the field lines. These particles are exceedingly small, almost beyond ordinary high powers of the microscope, and the striated ferric oxide, which it seems to be, can be caught on a microscope slide while the magnetic field is on, and studied under high powers.

The remarkable thing is the small amount of the iron smoke needed to produce the effect and the instantaneous response to very weak fields. Thus, if an open coil or helix without a core of iron be traversed

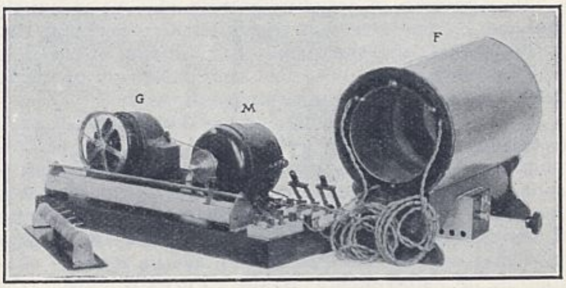


FIG. 2.

by a fluctuating or slowly alternating current, the flickering may be shown by a detector constituted by holding the open neck of a glass flask over an iron arc for a few moments. Some of the smoke enters the flask, which can then be corked. Such a flask has shown flickering at a distance of twelve feet away from the small coil, through which a low frequency current was sent; and, curiously, when the flask was placed near the coil, the flickering was replaced by a steady illumination. When gradually removed from the coil in the direction of its axis, the flickering became more and more pronounced.

This indicates that the orientation, or arrangement of the particles to correspond with the field lines, takes place with a weak field, and almost instantaneously in a strong alternating field, in the latter case being accomplished and maintained throughout the whole wave of current. The zeros seem to be without effect in arresting the appearance, while at a considerable distance away from the same coil, excited as before, the weaker field at such a distance can only orient the particles at or near the maxima of the current waves. This seems to indicate that a certain very low value of the magnetising force is sufficient for the orientation or alignment of the particles. Retention of vision by the eye may also cover up any very short interruptions in the luminous effect itself.

Use has been made since the publication of the original descriptions of the effect for rendering visible to the eye a rotating field produced by biphase, three-phase, or polyphase currents. The effect is unique, and it can be photographed.

In the accompanying illustrations, Fig. 1, *a*, shows a box with a glass front and back, a beam of light being sent in from the back with no excitation or magnetic field present; Fig. 1, *b*, shows the same with the coil lying flat on the top conveying current. In this case it is clear that a luminous effect, displaying the field of the coil, has been depicted. In each case, of course, iron arc smoke has been within the box at each trial; it being allowed to enter through a hole at the bottom of the box seen indistinctly in the figures. It is surprising, too, how long a time it takes for the fumes to settle out of the air within the apparatus.

In Fig. 2 is shown a device for rendering visible a rotating field, such as that of a three-phase motor. The structure at *F* is, in fact, a field winding, clearly showing in the photograph the three entering wires for its excitation. As the ordinary frequencies would be too high for observation, the rest of the figure to the left shows a small motor *M* driving at reduced speed a small generator *G* of the three-phase currents needed for the excitation of the field at *F*. Usual arrangements are provided for varying the speeds, and thus the cyclic rate or frequency of the currents in *F*. The interior of *F* is arranged with glass ends so that it may receive illumination from the back, and also that it may receive and retain iron arc smoke. In this way the revolving field inside the structure *F* becomes distinctly visible by a luminous glow revolving within it.

The direction of revolution may also be instantly changed by the switches provided for reversing two of the phases, and the speed of revolution of the field may be made slow, or so fast that retention of vision results in a continued interior luminosity.

It is probable that with further development, such arrangements may be designed to make use of this magneto-optical phenomenon in the study of distortions in alternating fields by the introduction of closed circuits in the form of rings, plates, and various forms of conductors, or even to compare the distortions produced by the material as well as the form of conductors in alternating fields. Perhaps, also, the distortions of field lines produced by revolving or moving conductors in even direct current fields may be exhibited or investigated. My time has not permitted much work, interesting as it may be, to be carried on.

ELIHU THOMSON.

July 5.

The Origin of the Nebulium Spectrum.

IN his letter to NATURE of Oct. 1, p. 473. Mr. I. S. Bowen has made the important suggestion that several of the chief lines in the spectra of gaseous nebulæ may be due to what spectroscopists have called 'forbidden' combinations of terms in the spectra of ionised nitrogen (N II), ionised oxygen (O II), and doubly-ionised oxygen (O III). It is, of course, no longer permissible to suppose the existence of hypothetical elements to account for the long-standing mysteries of nebular spectra, and we must accordingly regard the nebular lines as being produced by known elements under conditions of excitation which have not yet been imitated in the laboratory. It has seemed natural enough to look to the lighter elements, and those who, like myself, have given special attention to the spectra of these elements under widely varied conditions, have doubtless kept in view the possibility of finding some indications of nebular lines in the course of their observations. Extensive experiments, however, have failed to reveal any traces of them.

The evidence put forward by Mr. Bowen in favour of ionised oxygen and nitrogen is already very substantial and demands careful consideration. The case for O III is, in fact, a good deal stronger than appears from his letter. I have lately been investigating the structure of this spectrum, and it may be of interest to refer to some of the results obtained.

Doubly-ionised oxygen has six external electrons, and some of the more important configurations (in n_k orbits), with the corresponding types of terms predicted by Hund's theory, are shown in the following table, the notation being that adopted in a recent paper on N II (*Proc. Roy. Soc.*, A, vol. 114, p. 662).

1.	2_1	2_2.	3_1	3_2	3_3.		Terms.
2	2	2				s^2p^2	$1^3P_{210}\ 1^1D'_2\ 1^1S'_0$
2	2	1	1			$s^2p.s$	$1^3P'_{210}\ 1^1P_1'$
2	2	1		1		$s^2p.p$	$1^3D'_{321}\ 2^3P_{210}\ 1^3S'_1\ 2^1D'_2\ 1^1P'_1\ 2^1S'_0$
2	2	1			1	$s^2p.d$	$1^3F'_{432}\ 1^3D_{321}\ 1^3P'''_{210}\ 1^1F'_3\ 1^1D_2\ 1^1P'''_1$

Without reference to the nebular lines, I have determined all of the terms on the second, third, and fourth rows, besides others, from my own (unpublished) observations. Utilising Bowen's observations in the extreme ultra-violet, the values of the three deepest terms follow as a matter of course, but are less accurate in consequence of the difficulties of measurement in this part of the spectrum. For the 1^3P terms, Bowen has found $1^3P_2 - 1^3P_1 = 193$, $1^3P_1 - 1^3P_0 = 116$, and the two green nebular lines are attributed by him to O III because of their separation $\Delta\nu = 193$. He thus identifies the nebular lines with the forbidden combinations $1^3P_2 - 1^1D'_2$ and $1^3P_1 - 1^1D'_2$, but, the value of $1^1D'_2$ being then undetermined, he gives no additional evidence in support of this view.

From singlet combinations in the extreme ultra-violet previously suggested by Bowen (*Phys. Rev.*, vol. 29, p. 241), in combination with the values of $1^1P_1'$ and $1^1P'''$ since determined by myself, it is readily found that $1^1D'_2 = 424385$, and $1^1S'_0 = 401472$. For the nebular lines, on Bowen's view, we thus have

λI.A.	ν
5006·84	$19967{\cdot}1 = 1^3P_2 - 1^1D'_2$
4958·91	$20160{\cdot}1 = 1^3P_1 - 1^1D'_2$.

Hence, $1^3P_2 = 444352$, $1^3P_1 = 444545$, $1^3P_0 = 444661$.

The assumption as to the nebular origins in question can be tested by the lines λ305·7 and λ374·3 previously suggested by Bowen as probably representing the regular combinations $1^3P - 1^3D$ and $1^3P - 1^3P'$ respectively, using the values for 1^3D and $1^3P'$ which I have determined. Unfortunately, each of these combinations yields six components, which cover but 0·29 A in the first multiplet and 0·36 A in the second, and so have not been resolved. However, the calculated wave-numbers for $1^3P - 1^3D$ range from 326986 to 327295, and compare very favourably with the observed line λ305·7, for which $\nu = 327118$. Similarly, the lines $1^3P - 1^3P'''$ range from 267134 to 267584, and are in good agreement with 267165 representing the observed line λ374·3. These considerations appear to give strong support to the view that the two green lines of the nebulæ are due to O III, but no further tests appear to be available at present.

The agreement in position of the nebular line λ4363·21 with the combination $1^1S'_0 - 1^1D'_2$ of O III is as close as can be expected, and further tests would seem to depend upon the possibility of measurements of lines in the extreme ultra-violet and in nebulæ with a still higher order of accuracy.

The evidence for attributing the nebular lines λ6583·6, λ6584·1 to N II appears to be very convincing, but the published observations of the N II spectrum in the extreme ultra-violet are inadequate to provide further tests.

Bowen's assignment of the strong nebular lines λ3728·91, λ3726·16 to O II leads to term values for 1^2D_{32} of the expected order of magnitude, and the consequent calculation of the red line λ7325 may be provisionally considered to support the suggested identifications. Owing to the apparent absence of regular intercombinations of doublet and quartet terms, however, the only test at present available would seem to be the discovery of one or more companions to the nebular line λ7325. If the identifications be correct, there should be a satellite about 10 A distant on the less refrangible side of this line, and a 'second chief' line in a position which cannot be predicted because the separation of the $^2P'_2$ terms has not yet been determined.

The numerical evidence, on the whole, thus appears to be in favour of Mr. Bowen's suggestions, and it is interesting to note that if these should be fully confirmed, the observations of nebulæ may be used to determine the structure and exact positions of certain unresolved lines in the extreme ultra-violet.

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Oct. 14.

The Rare Earths.

IN searching for evidence that would enable a decision to be made as to the exact distribution of the electrons responsible for the series of fifteen 'rare earth' elements from lanthanum to lutecium, the colour of their salts appears to be of prime importance, particularly as it is known that colour is intimately associated with movements of electrons in atoms. The fact that many of the rare earths yield coloured salts has led to considerable uncertainty as to their proper place in the periodic classification, and many attempts have been made to allocate them to appropriate periodic groups on the grounds of valency, isomorphism, and colour analogies.

I have recently shown (*Jour. Chem. Soc.*, Sept. 1927) that the foregoing fifteen rare earth elements are all analogues of scandium, the last fourteen of them forming an anomalous subseries of the transition subperiod of the third long period of the classification. This arrangement rules out any possibility of allocating these elements to more than one periodic group. It follows, in consequence, that the rare earths have no real relation to any other series of elements and that the observed colour resemblances are fortuitous.

Examination of the colours of the salts of these elements from this new viewpoint has brought to light colour sequences hitherto unrecognised, the sequence of colours of the salts of the first eight rare earths being identical with that of the last eight in reverse order. Lanthanum, cerium, praseodymium, neodymium, illinium, samarium, europium, and gadolinium salts are colourless, colourless, green, red, unknown, yellow, faint rose, and colourless respectively, while those of lutecium, ytterbium, thulium, erbium, holmium, dysprosium,[1] terbium, and gadolinium show the same colour sequence, with the apparent exceptions of terbium and holmium.

The salts of terbium, the 7th member of the 2nd series, are recorded as colourless, but in thick layers they are almost certainly faintly rose, for they exhibit absorption at the blue end of the spectrum. Terbium is thus analogous to europium, the 7th member of the 1st series, the salts of which are either faintly rose or colourless and exhibit absorption mainly at the blue end of the spectrum.

The salts of holmium, the 5th member of the 2nd series, are known to be yellow, whereas the salts of the recently discovered element illinium, the 5th member of the 1st series, are as yet unknown. From the duplicate colour sequence, however, it may be predicted with confidence that illinium salts when obtained will be yellow like those of holmium. The yellow colour predicted for illinium salts may partly explain why illinium was not sooner detected in the intensive researches on rare earth separations of the last century, for samarium, with which it is naturally associated, is nearest in atomic weight, yields yellow salts, and probably exhibits absorption in the same spectral region.

As the duplicate colour sequence shown in the following table relates to the trivalent ions of the elements, the numbers in the 1st column are the actual numbers of electrons in the ions (3 less than the atomic numbers).

54 La, 68 Lu	colourless	0, 14	0	(0, 0), (6, 8)
55 Ce, 67 Yb	,,	1, 13	+1, −1	(1, 0), (6, 7)
56 Pr, 66 Tm	green	2, 12	+2, −2	(2, 0), (6, 6)
57 Nd, 65 Er	red	3, 11	+3, −3	(3, 0), (6, 5)
58 Il, 64 Ho	yellow	4, 10	+4, −4	(4, 0), (6, 4)
59 Sa, 63 Dy	,,	5, 9	+5, −5	(5, 0), (6, 3)
60 Eu, 62 Tb	faint rose	6, 8	+6, −6	(6, 0), (6, 2)
61 Gd	colourless	7	±7	(6, 1)

In the 3rd column are shown the numbers of electrons in the ions after deducting the 54 of the La ion (xenon structure). The 4th column shows the variation of these electrons from 0 and 14, cerium for example having 1 electron and ytterbium −1 (1 less than 14). The identity in the colour sequences indicates that the same colour is obtained in two different ions when one has as many electrons more than zero as the other has less than 14.

There being only two colour sequences, it may be regarded as certain that the 14 electrons concerned are arranged in only two sets or subgroups. Further, as gadolinium is the only element common to both sequences, being the last of the first sequence and the first of the reversed sequence, it may be inferred not only that gadolinium has electrons in both subgroups, but also that the second subgroup begins when the first is complete. As gadolinium has 7 electrons and lutecium 14, it follows that the former has the subgroup structure 6, 1, and the latter 6, 8. The complete distribution of the 14 electrons in the rare earth elements is given in the last column of the table.

It can be no more than a curious coincidence that the number of electrons in each ion from gadolinium to lutecium is expressed by the same figures as the numbers of electrons in the two subgroups, the gadolinium ion, for example, having 61 electrons and the subgroup structure 6, 1.

In Bohr's theory of atomic structure, the maximum number of subgroups in a quantum level is equal to the quantum number, and the maximum number of electrons in a subgroup is equal to twice the quantum number. In the 4-quanta level there should thus be 4 subgroups of 8 electrons each, this structure being attained in lutecium by the increase of 3 subgroups of 6 each to 4 of 8 each, thus involving four types of subgroup change though only two types of change are evident from the duplicate colour sequence.

Early in 1924 I pointed out that the experimental facts of emission and absorption X-ray spectra indicated a number of quantum subgroups invariably greater than is given by Bohr's rule. The intensities of the emission lines and the widths of the absorption bands further indicated that the numbers of electrons in subgroups could not be equal, evident also from the fact that the number of subgroups in a level is always an odd number, while the total number of electrons in a level is always an even number. I deduced that the 4-quanta level must contain 7 subgroups of 2, 2, 4, 4, 6, 6, 8 electrons, and suggested a new law of uniform atomic plan that the maximum number of subgroups in a quantum level is equal to one less than twice the quantum number, and that the maximum numbers of electrons in subgroups is equal to twice the natural numbers taken in duplicate, the last and largest subgroup being unduplicated and equal to twice the quantum number. This law was supported by relevant chemical evidence, and has since been confirmed by Stoner's work on spectral multiplicity. The foregoing electronic structures for the rare earth elements, as deduced from the duplicate colour sequence, fully confirm the law of uniform atomic plan, the subgroups for the 4-quanta level being 7 in number and consisting of 2, 2, 4, 4, 6, 6, 8 electrons as in lutecium.

The arrangement of the rare earths into the fore-

[1] Hopkins, in "Chemistry of the Rarer Elements," p. 107, gives the colour of dysprosium salts as "bright green." This is an error, all being in fact golden yellow.

going two series accords completely with their analytical separation into two groups, the cerium earths lighter and the 'yttrium' earths heavier than gadolinium. Details of the division of the rare earths into the two series on other chemical and crystallographic grounds will shortly be submitted to the Chemical Society.

J. D. MAIN SMITH.
University of Birmingham,
Sept. 20.

The Films Responsible for Oxidation Tints on Metals.

THE colours produced by heating metals in air have long attracted interest. Within the last three years it has proved possible in two cases (lead and iron) to separate from the basis metal the oxide-films responsible for these tints. In the case of lead, which is liquid at the requisite temperatures, the oxide-film is lifted off the molten metal on glass (*Proc. Roy. Soc.*, A, **107**, 228; 1925), whilst in the case of iron the method employed is that originally worked out for the isolation of the much thinner, invisible skin responsible for the passivity of iron treated with oxidising agents. This method (*Jour. Chem. Soc.*, 1020; 1927) consists in undermining the oxide-film by dissolving away the metal below it with iodine solution, so that the film comes peeling off in curling fragments, which can be washed by decantation and examined under the microscope.

The chemical aspects of the matter have been discussed in the two papers quoted above, but there are certain physical observations which may perhaps deserve to be put on record. There is a remarkable difference between the oxide-films stripped from lead and iron respectively. The lead oxide film is highly transparent, and the film itself, when separated from the metal, shows interference colours, depending on the thickness, the tint by reflected light being always complementary to the tint by transmitted light. As a result of the transparency, the higher order colours corresponding to thick films can easily be observed, the second-order tints being as vivid as the first-order colours; at greater thicknesses third and fourth orders appear. The sequence of tints is essentially the same as that exhibited by silver exposed to iodine vapour, silver iodide also being a transparent substance.

When we come to iron, however, the state of affairs is different. Viewed by reflected light, the film fragments show a brilliant metallic lustre, and in some cases might easily be mistaken for metallic iron; they retain all the surface irregularities displayed by the original metallic surface before its conversion into oxide; thus if the abrasive treatment originally used to produce a clean metallic surface has left a series of microscopic grooves and ridges on the metal, the films are crenulated in a manner which faithfully reproduces these grooves and ridges. However, on altering the illumination so that the films are viewed by transmitted light, it is at once seen that they consist of a transparent substance, with only occasional opaque points consisting mainly of minute spots of residual metallic iron embedded in the oxide and usually arranged in lines following the grooving (these particles of residual iron are best shown up as expanding blue spots by treating the film fragments with an acid solution of potassium ferricyanide). But the transparency of the oxide films is distinctly less perfect than that of the corresponding lead oxide films; even the film responsible for the first-order yellow tint has a perceptible yellowish-grey colour, clearly due to specific absorption, whilst the films become darker and darker as we proceed along the sequence, so that the films to which the second-order tints are attributable show a quite dark brownish-grey appearance by transmitted light.

This specific absorption is more than sufficient to mask any colour due to interference, and consequently the films—unlike those separated from heated lead—do not themselves show bright tints, although the 'character' of the brown colour varies slightly with the thickness—possibly as the result of interference of the 'thin-film type.' It may perhaps seem curious that the films should nevertheless produce colours when in contact with the metal. In my opinion an explanation can be given. Any theory based on interference between the light reflected respectively from the outer and inner surfaces of the film would lead us to expect that a *slight* degree of opacity will, at low film thicknesses, actually favour the production of colour, since it will tend to reduce the inequality between the intensity of the two reflections; when, however, the film is off the metal, the two reflections would be approximately equal in intensity in the case of a highly transparent film, and the slightest opacity will be unfavourable to the effect. The serious opacity of the thicker films of iron oxide explains why the second and third order tints—so conspicuous in the case of lead—are badly developed on iron, even when the film is still on the metal. After the end of the first-order tints, the colours become faint and are modified somewhat by the specific colour of the scale, which, although slightly yellowish by transmitted light, is a rather bluish grey by reflected light. Nevertheless, there has been no difficulty in tracing the sequence as far as the third-order red, the sequence being essentially the same as that shown by lead or copper.

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Adsorption of Gases on the Surface of Mercury.

CERTAIN methods of measuring the surface tension of mercury, especially the 'big-drop' method as used by Popesco (*Ann. de Physique*, **3**, p. 402; 1925), appear to show that the presence of air or other gas increases the surface tension of a freshly formed surface by about 100 dynes. The 'drop-weight' method, on the other hand, shows a difference of only a few dynes between the values in air and *in vacuo*, and this indeed in the opposite sense to that indicated above (Harkins, *Jour. Am. Chem. Soc.*, Dec. 1920). Observations by the writers using the same mercury in order to measure its surface tension by the above as well as other methods show that the differences in the measured values of the surface tension are due to differences in the method and not to differences in the quality of mercury (*Trans. Faraday Soc.*, May 1927).

It is therefore especially important to gain some information as to the adsorption of gas by a freshly formed mercury surface. This has now been accomplished by applying to gases a method similar to that used by Schofield for solutions (*Phil. Mag.*, Mar. 1926). A shower of about 500 drops per second of mercury falls down a vertical tube about 50 cm. long to the middle of which is sealed a side-tube. Through this side-tube is fed a slow stream of either hydrogen or argon containing a small percentage of carbon dioxide. The stream of gas divides and is taken from the vertical tube by two outlets, one near the top and the other near the mercury surface at the bottom of the tube. From these outlets the gas passes to the tubes of a Rayleigh interferometer.

Any gas adsorbed by the falling drops is given up at the bottom of the tube, and if the carbon dioxide is selectively adsorbed, this will cause an increase in its concentration in the lower tube and a corresponding decrease in the upper tube. By counting the drops and measuring the volume of mercury passing each second, the area of surface can be estimated, while the concentration change indicated by the interferometer and a knowledge of the rate of flow of the gas enable the amount adsorbed per unit area to be calculated. Measurements indicate that for concentrations of 5, 10, and 15 per cent. carbon dioxide in either hydrogen or argon, approximately a complete monomolecular layer of carbon dioxide is adsorbed within one-fifth of a second after the surface is formed. At a concentration of one-half per cent. the adsorption appears to be definitely less, and at fifty per cent. definitely more, than is accounted for by a monomolecular layer.

Later it is hoped to publish a detailed account of the work, together with measurements of surface tension of both the 'big-drop' and 'drop-weight' methods of surfaces formed in similar mixtures of gases. Measurements of the weights of mercury drops falling from tubes wetted by the mercury (amalgamated platinum or copper) in general yield greater values for drops formed in air than for those formed *in vacuo*, so it seems at least possible that the 'drop-weight' method of measuring surface tension gives different values according to whether the liquid does or does not wet the tube.

M. L. Oliphant.
R. S. Burdon.

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Periodicity of Molecular Numbers.

I believe the following facts will serve a purpose in disclosing a new molecular structure principle. Construct a table as follows:

A	*B*	*C*	*D*
—	—	0	2
4	6	8	10
12	14	16	18
20	22	24	26
28	30	etc.	etc.

Let these figures represent molecular numbers (total atomic numbers) of compounds containing no elements beyond scandium. The distribution of mole-

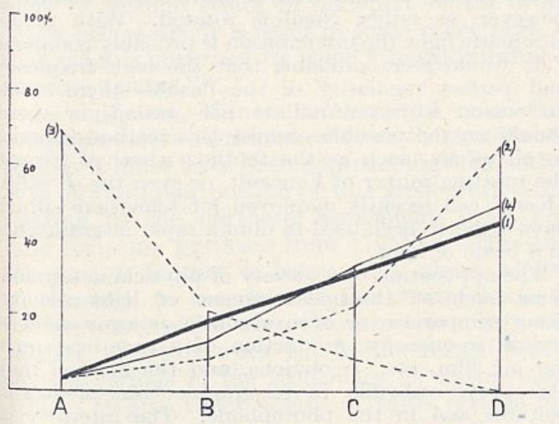

Fig. 1.

cular numbers of certain classes of substances among these four groups reveals a marked preponderance of one group and a corresponding deficiency towards another. The diagram (Fig. 1) indicates the percentage of occurrence, in each group, of the following sets of compounds: (1) 244 gases having b.p. 100° C. or below; (2) 57 inorganic acids; (3) 24 most familiar bases; (4) a random set of 60 ions where a unit was added to or subtracted from the total atomic numbers of each for every negative or positive charge respectively.

The striking contrast between the curves of acids and bases is significant, as well as the similarity between those of gases and ions. There is the following connexion between my table and isometric polyhedrons, on the grounds that atomic numbers represent fundamental units which tend to occur in pairs: a pair on each face of a cube, or of combinations thereof, produce numbers of group *A*, or of group *B* if a pair be assumed in the centre of the configuration as well; a pair on each face of *any* isometric solid, excepting those just mentioned, will give a number of group *C*, or of group *D* if a pair be also assigned to the centre. It may be stated that the properties of ions and molecules are periodic functions of their molecular numbers, under certain restrictions, and it must not be overlooked that we are now considering only the first 21 elements of the periodic system, for reasons which cannot be discussed here.

L. W. Tibyriçá.

Caixa 1330,
São Paulo, Brazil,
Aug. 15.

Critical Potentials of Copper by Electron Impacts.

The following method has been used successfully in the determination of some of the critical potentials of copper by electron impact. Essentially the method is the ordinary three electrode one in which an equipotential source of electrons, a gauze, and a receiving electrode are used. The gauze in this case was made of a copper strip 0·025 mm. thick, through which holes were bored. This gauze was heated electrically and served as a source of copper vapour, the electrons being accelerated to it at the same time.

The critical potentials observed, together with the values calculated from the spectroscopic data given by L. A. Sommer (*Zeit. f. Phys.*, p. 711, Nov. 1926), are as follows:

State of Atom.	Observed volts.	Sommer's value.
Ionised	7·7	7·69
$^2D_3$, $^2D_2$	1·61	1·38, 1·64
2^2P_1, 2^2P_2	3·80	3·77, 3·80
$^4P_3$	4·84	4·87
$^2D_3$	5·65	5·75
3^2P_1	6·08	6·09
3^2S_1, D	6·73	6·52, 6·75
$^2D_3{}^2$	8·26	8·28
$^2G_5$	8·73	8·73
$^2P_1$	9·40	9·27
...	10·07	10·01
Ionised	10·91	10·90

One other critical potential observed at 2·6 volts corresponds to no spectroscopic transition and may possibly be due to an impurity.

The question might be raised whether the value of 9·4 volts might not correspond to an ionisation from the metastable *D* state. This would require 9·52 volts. This does not seem probable, however, as it would require two electron impacts. On account of the low vapour density available and small electron current, any effect depending on two electron impacts would be too slight to be noticeable.

The method is being applied to other metals.

H. B. Wahlin.

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Mud Volcanoes of Minbu, Upper Burma.

THE accompanying photographs of the mud volcanoes of Minbu in Upper Burma may be of interest to readers of NATURE. Minbu is on the Irrawaddy, near the oil-fields of Yenangyaung. The volcanoes are small hillocks of grey mud or clay. The hills begin as holes, from which mud oozes and forms continually growing cones. Inflammable gases are also exuded with the mud. The local people associate superstitious ideas with the volcanic activity.

Fig. 1 is a general view of the mud volcanoes. Fig. 2 shows instantaneous stages of bubbles of mud in the crater of the largest volcano. The crater is about 5 ft. across; and the bubbles in Fig. 2 were about $1\frac{1}{2}$ ft. in diameter. The mud is thick, but cold, with a faint odour suggestive of crude petroleum.

FIG. 1.—Mud volcanoes at Minbu.

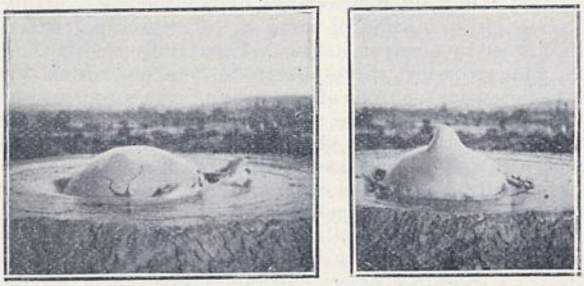

FIG. 2.—Stages in bubble formation.

V. V. SOHONI.

Alipore, Calcutta, India.

Flame and Combustion.

WE want to thank Prof. Armstrong for his breezy review of our book in NATURE of Sept. 24 and his suggestions for improving our brains. Before putting on the 'thinking cap,' however, we would like to ask him why, in discussing flame-reactions, he asserts that we "ignore the prime fact, that the heat of combustion of carbonic oxide is *below* that of hydrogen; . . . It cannot, therefore, be oxidised by steam"? For, in our 'nursery' days, we were taught that it is the other way round, and that, volume for volume, hydrogen burning to *steam* gives out about 16 per cent. less energy than carbonic oxide burning to carbon dioxide; also that the change from the system $CO + H_2O$ (steam) to the system $CO_2 + H_2$ is exothermic. If, as Prof. Armstrong says, we are wrong, we have sinned in such good company as Berthelot, Julius Thomsen, and indeed every other investigator of heats of combustion. On the other hand, if we are right, does not the 'snag' in his combustion theory thus stand self-revealed? Is there, indeed, any evidence that not 'hydrone' (steam) but something much more complex and 'hydronolic' (water) is formed in flames?

Doubtless Prof. Armstrong will dismiss all this as of no consequence, as he does our spectroscopic evidence, namely, that the flame spectra of dry CO-air explosions at high initial pressures show no vestiges of 'steam lines.' We regard it as conclusive against his theory. Such being the case, we do not wonder that he wants our laboratories to be shut up whilst he settles the matter for us intellectually.

WILLIAM A. BONE.
D. T. A. TOWNEND.

THE heats of formation given by Thomsen are:

$$H_2, O = 68360$$
$$CO, O = 67960$$

I take into account the heat of formation of water, not that of hydrone (steam), between which there is a profound difference. Prof. Bone already has kindly given me credit for carrying my imagination far in these matters: I would ask him to try to follow me ere we begin to dispute.

H. E. ARMSTRONG.

High-Frequency Interruption of Light.

AT my suggestion, Messrs. Adam Hilger and Co. have made the experiment of passing a beam of light through a quartz piezo-electric resonator placed between crossed Nicol prisms.

When the crystal plate is excited to resonant vibration by an applied oscillating voltage from a valve-circuit, light is strongly transmitted, and examination of this light in a rotating mirror shows that it consists of regular flashes, the frequency being apparently double that of the electrical oscillations. The effect is best obtained when the light is passed in a direction parallel to that of the optic axis or, to avoid rotatory dispersion of white light, at an angle of $22^\circ\frac{1}{2}$ with this axis. An attempt to photograph the flashes passing through a crystal oscillating at 144 kilocycles per second on a high-speed film camera was unsuccessful, but faint striæ were obtained on a plate moved slowly across the beam after resolution.

Any bright source of light may be used, the colour of the flashes of light from a white source changing, however, as either Nicol is rotated. With monochromatic light the interruption is probably complete.

It would seem probable that the high frequency and perfect regularity of the flashes—there seems no reason why ten million per second, or more, should not be possible—render this method superior to all others, such as the toothed wheel of Fizeau, the rotating mirror of Foucault, or even the so-called 'Kerr' cell recently employed for television—which have hitherto been used to obtain rapid intermittence in a beam of light.

The application to a variety of physical determinations such as the measurement of light-velocity, exact comparison or even absolute determination of crystal frequencies, production of a time-base on a moving film, etc., is obvious, and the method may also prove valuable in telegraphic transmission of pictures and in the photophone. The intensity of the flashes can readily be modulated by modulating the oscillating voltage applied to the crystal.

I wish to thank the management of Messrs. Adam Hilger and Co. for so kindly giving facilities for the experiments, and Messrs. Underhill and Brown of their staff for the interest and skill which made the demonstration of them a success.

KERR GRANT.

Clustering and Periodicity of Earthquakes.

By Dr. Charles Davison.

EVERY few years we pass through a season of marked earthquake-frequency, or, as Mallet called it, a ' period of paroxysmal energy.' In the mere fact of clustering, there is nothing remarkable; it is its intensity, rather than its existence, that is worthy of notice. In Italy, for example, as Mercalli pointed out, 209 destructive earthquakes occurred between the years 1601 and 1881, and 182 of them in 103 years.[1] In other words, the average frequency of great earthquakes during one of the cluster-years was eleven times that during one of the remaining years.

The first seismologist who examined the clustering of earthquakes, the first, indeed, who possessed the necessary materials, was Robert Mallet. In 1858 he drew curves representing the frequency of earthquakes in each year from 1500 to 1850. The intervals between successive maxima in these curves varied widely. Though he could trace no law in their variation—it should be remembered that he counted weak shocks as well as strong—their average duration was found to lie between five and ten years, the shorter intervals being those of fewer, and usually weaker, earthquakes.[2]

Fifty years later, John Milne went close to the heart of the problem by suggesting that variations of seismic activity in distant regions may be synchronous. Considering the earthquakes from 1899 to 1907, he noticed that, during the last six years, the annual numbers of ' large earthquakes ' on the eastern and western sides of the Pacific rose and fell together. In the following year he found that the destructive earthquakes of Italy and Japan during the last three centuries occurred in periods of activity, the intervals between them ranging from five to twenty years, and that, of the eighteen years of maximum frequency in Italy, fourteen agreed with years of similar activity in Japan. "These coincidences suggest," he says, "that a relief of seismic strain in one part of the world either brings about a relief in some other part, or that relief is governed by some general internal or external agency."[3]

At this time, Milne's catalogue of more than 4000 destructive earthquakes[4] was still unpublished, though it must have been approaching completion. It is on the fuller portion of this great work—that relating to the northern hemisphere from 1750 (and for some purposes from 1701) to 1899—that the present inquiry is based. My object at first was merely to ascertain if the cluster-years for different intensities were the same or in any way related, and this work led to the recognition of several periods in the recurrence of cluster-years. I hope to give fuller details of these periods in a later paper.

To each earthquake Milne assigned an intensity according to a scale of three degrees. Shocks of intensity I. were strong enough to crack walls or chimneys or to shatter old buildings. By those of intensity II., buildings were unroofed or shattered and some were thrown down. Earthquakes of intensity III. destroyed towns and desolated districts. In order to smooth away minor inequalities, I have taken three-yearly means of the annual numbers of earthquakes of each intensity. The corresponding curves show definite years of clustering, which are given in the following table:

	Int. III.	Int. II.	Int. I.	Sunspot Minimum.
A	1754–56	1755–56	1755–56	1755
B	1765–66	1767	1766–67	1766
	..	..	1771–73	1775
C	1785–90	1784–86 1789–91	1785–86 1791–92	1785
	..	..	1799–1800	1798
D	1810–11	1811	1811–13	1810
E	1822–23	1818–20	1821–22	1823
F	1828–29	1827	1827–29	..
	1834–36	1832	..	1833
G	1840–41	1840–42	1840–42	1843
H	1845–47	1846–48	1846–47	..
J	1852–57	1852–56	1852–57	1856
	..	1859–60	1861–63	..
K	1868–72	1869–72	1867	1867
	..	..	1873–74 1880–81	1878
L	1884–86	1884	1885–86	1889
M	1892–93	1893–94	1895	

It will be seen that, in all three classes, there are twelve clusters at approximately the same times. They are denoted by the letters A-M.[5] There are also six other clusters, two common to two classes, and four of earthquakes of intensity I. only. Of the latter, two may not be real exceptions, for in the other classes there are traces, too slight to be otherwise noticed, of clusters about the years 1773 and 1798. In any case, the existence of at least four of these additional clusters seems to imply that they are not consequences of the great shocks of intensity III., but rather that the clusters of all classes are the effects of some common cause or causes.

More important, however, than the coincidences of the clusters are the intervals between the years of maximum frequency. Some of the intervals are so suggestive of an eleven-year period that it was only natural that the cluster-years should be compared with the turning epochs of sunspot frequency. The last column of the table shows that eight clusters in all three classes (A-E, G-K) agree closely with the years of low sunspot frequency, and that this correspondence also holds for three other clusters (1771–73, 1799–1800, and 1832 or 1834–36) which appear in only one or two classes. The only divergences are for the last two years of sunspot minima.

[1] G. Mercalli, "Vulcani e fenomeni vulcanici in Italia," 1883, pp. 353-355.
[2] Brit. Ass. Rep., 1858, p. 49 and plates 1-6.
[3] Brit. Ass. Rep., 1908, pp. 63-64; 1909, pp. 56-58.
[4] Brit. Ass. Rep., 1911, pp. 649-740.

[5] The date of the maximum epoch M may be too early, for, towards the end of the century, the catalogue may not be quite complete.

In order to test more closely the existence of an eleven-year periodicity, I counted the numbers of earthquakes of each intensity in the years 1755, 1766, . . . , 1887; 1756, 1767, . . . , 1888; and so on, and took five-yearly means of these eleven sums, with the following results, the first subsequent year of least sunspot frequency being 1765:

Intensity.	First Maximum Epoch.	Amplitude.
III. . .	1764	0·16
II. . .	1762–63	0·12
I. . .	1763–64	0·09

Thus, in destructive earthquakes of every intensity, the maximum-epoch of the eleven-year period occurs shortly before the epoch of least sunspot frequency; and the amplitude increases with the intensity of the shock. It may be added that the epochs are almost exactly the same for the same three classes for the separate intervals 1701–99 and 1801–99, and for all three intensities together for the interval 1501–1698, and for each season of the interval 1701–1898.

It is interesting to notice that the same periodicity holds in widely separated regions. Taking the three intensities together, the maximum occurs in 1764 in Europe, in 1763–64 in Asia, in 1764 in Italy, in 1764–65 in China, and in 1763–64 in the island groups of the western Pacific. Even in the slight earthquakes of Great Britain, the same period is present with its maximum in 1763–64. Thus, by a somewhat different line of evidence, Milne's remarkable generalisation seems to be confirmed.

In addition to the eleven-year period of destructive earthquakes, there are other clearly marked periods of 19, 22, and 33 years, the maximum epochs of which (1754, 1760, and 1757) agree closely in widely distant regions of the northern hemisphere. Some of these maxima seem to be responsible for clusters in the above table, especially for those of the years 1791, 1847–48, 1880–81, and about 1887. To the occurrence of their minima about the years 1798, 1833, and 1878, the absence or slightness of clusters is probably due.

During the present century, the maxima of the 11, 33 and 19 year periods occurred in 1918, 1922 and 1925; those of the 11, 22 and 33 year periods are due in 1951, 1958 and 1955; and those of the 11, 22, 33 and 19 year periods in 1984, 1980, 1988 and 1982. The times of unusually frequent earthquakes are thus, 1918–25, 1951–58 and, especially, 1980–88. The first of these intervals is notable for its very numerous earthquakes, some of which, such as the Chinese earthquake of 1920 and the Japanese earthquake of 1923, were of great violence.

Invention as a Link in Scientific and Economic Progress.[1]

By Sir James B. Henderson.

INVENTION forms the natural link between physics, chemistry, and engineering, and every advance in one or other of these produces a reflex action on the other. For example, a discovery in physics which increases accuracy of measurement by providing an indicator more sensitive than any previously known, is soon embodied in an engineering instrument carefully designed and manufactured for sale at a price which makes it available to every physicist for use in further research. Thus modern research in physics and chemistry is carried out with accurate apparatus which would be available only at a prohibitive price if it had been made for the particular research alone. The assemblage of apparatus used in a modern research is sometimes like an engineering installation, and is in marked contrast with the cruder, home-made apparatus, designed *ad hoc*, which was common a generation ago.

The closer the intercourse between the physicist, the chemist, and the engineer, the greater will be the fertility in invention and the faster the economic progress. The physicist working continually in a laboratory where everything is specially designed to facilitate accuracy of measurement and to eliminate disturbance, is apt to forget how artificial his working conditions really are, and that before any of his beautiful experiments can have a practical application in industry a great deal of invention is required.

As an example of successful invention involving an accurate measurement to be made under practical conditions unsuitable to accuracy, I may cite the Barr and Stroud range-finder, which was invented by two young professors in the Yorkshire College, Leeds. The problem consisted in measuring with great accuracy, say to a second of arc, the small angle subtended at a distant target by a short fixed base placed at the observer. At the time when this invention was made, some forty years ago, the only scientist who normally measured angles to seconds of arc was the astronomer with his large telescopes mounted on great concrete foundations, with graduated circles from three to six feet in diameter and microscopes to read the scales. It seemed, therefore, impossible to contemplate the measurement of angles with anything like equal accuracy on board a rolling ship and with no expert operator.

Yet the two inventors, seeing an advertisement in the pages of *Engineering* announcing competitive trials of range-finders to be held by the War Office, took this seemingly impossible task in hand. There was little time to spare. The first instrument was designed in outline in a week, and much of the subsequent success is attributable to the sound physical principles underlying this

[1] Continued from p. 553.

design and to the very ingenious design of all the constructional details, due to the happy combination of an engineer and a physicist, both of whom were men of imagination with a *flair* for invention. Their range-finder was constructed in the College buildings and, to indicate the amount of time that was available, the final adjustment of the instrument was made on a star from the railway platform at Rugby on the way to the trials at Aldershot.

During the trials the instrument worked well at first, but after the sun came out it commenced to read 'as thousands of yards ranges which were palpably a few hundred' and the inventors discovered that their beautiful angle measurer was also a thermometer and a sunshine recorder combined. They were not surprised to have it rejected, and they might actually have abandoned it entirely if they had not been asked by the Admiralty some time later to submit an instrument for naval use. Then followed ten years of most patient struggle against physical and engineering difficulties, not to mention financial difficulties, for the inventors acted as their own promoters and the financial side of the business must have taxed their resources to the utmost. But at last they succeeded, and their range-finder is now the standard instrument in the British Army and Navy, and in other countries as well, and has been the foundation of one of the best firms of scientific instrument makers in the country. As student or as assistant I had the honour to serve under both Prof. Barr and Prof. Stroud, both of them great teachers, versatile inventors, and most lovable men, and I am happy to be able to pay this small tribute to them and to their great achievement.

THE DIFFICULTIES OF INVENTION AND THEIR REMEDY.

I wish it to be understood that where I have used the word 'invention' I am dealing with the great inventions, and not with the thousand and one minor and comparatively unimportant, though useful, inventions which flood the Patent Office every year. The latter are generally simple affairs, a minor improvement in a known mechanism or a new way of performing an old simple function. I do not wish to belittle these minor inventions in any way. They serve their purpose in our everyday lives, and all are traceable more or less directly to some major invention of the past, but the distinction which I wish to draw is that in very few cases is their manufacture or development a matter of difficulty. I am therefore dealing solely with the big inventions and their development, and it is to the question of the obstacles that are too often encountered in their development that I wish to draw particular attention. I wish now to examine the question of how to eliminate, or at least minimise, these difficulties that obstruct the inventor and so retard the march of progress.

The first way that suggests itself to me is by means of education. Our educational policy in schools on the scientific side deals with physical laws as facts, and the teacher generally deals only with phenomena with which he can afford to be dogmatic and ignores the enormously greater range of phenomena about which science knows little or nothing. This system inevitably breeds in the student and in the general public the impression that Nature acts according to certain definite laws and that there is nothing about these laws which is not known to science. In actual fact, the more the scientist knows about these laws the more he is impressed with his ignorance and the failure of science to fathom the complexity of Nature. Much of the misunderstanding of invention and its difficulties is due to this method of teaching, and will endure so long as this method is maintained. If it were possible to teach physical and chemical science historically, much could be done to counteract this injurious effect.

The experimental laboratory tends to modify the dogmatic teaching of the schools because the student there finds out for himself how exceedingly difficult it is to prove experimentally some of the simplest of the physical facts which he learned in the lecture room, and he thus gains a first-hand knowledge of the order of accuracy of physical measurements and of the difficulty in attaining it. Science taught historically would be infinitely more interesting and instructive, but time is the great obstacle. In a recent leading article in the *Times* the teaching of the history of science was advocated as a subject for general culture, and comment was also made on similar recommendations emanating from an American writer. Such a study would introduce a better understanding of the science of invention among those who have not given particular attention to it, and the inventor might come to be regarded as a necessary and valuable cog in the wheel of industrial progress, and not, as he is too often regarded, as a freak. After all, the inventor is simply trying to make things simpler and easier and safer for his fellow-men, and he is succeeding beyond belief. Surely that object is worthy of recognition and encouragement.

A second possible remedy to encourage invention and minimise its difficulties is by means of legislation. I hesitate to enlarge on this point because the question of patents is a controversial one among scientists, and between inventors and the outside public, but it seems to me anomalous that a man who makes an epoch-making invention which is going to revolutionise an industry and add millions to the wealth of the nation, receives exactly the same degree of protection for his invention as the man who invents a new kind of shirt button. In the first case the invention will take years to develop, and may cost thousands of pounds in the process, and by the time it reaches the productive stage the patent may have expired. In the case of the shirt button, a term which I use figuratively, there are no difficulties to overcome, practically no expense, no loss of time, and a clear sixteen years' trade monopoly.

I know that a patent is granted only for a new method of manufacture, which has to be described in the patent specification so that any one skilled in the art may put it into practice at once. In simple inventions which form the subjects of the great majority of patents this is actually the case, but there are undoubtedly cases where what appears to the inventor to be a practical scheme, and was honestly described by him as such, proves afterwards to be difficult to put into effect on account of technical difficulties which he had not foreseen, and the remedy for which may not be patentable. Such obstacles and their remedy cannot be recorded in the patent, because they have not been encountered when the specification is written. Under our present system a period of nine months is allowed between filing the provisional and complete specifications, which period, while ample in the case of most inventions, is inadequate for full investigation of the really great inventions, and it is to this difference between major and minor inventions that I wish to direct attention.

In America it is possible for an applicant for a patent, by filing periodical amendments of his specification, to keep the application pending in the Patent Office for a number of years, during which he can be developing the invention and adding to the specification any further explanations which may be called for in the light of the experience gained. Then when the patent is eventually issued, it runs for seventeen years from the date of issue, whereas a British patent dates from the date of application. In addition to this, an American patentee, on any question of priority of invention, is allowed to produce any evidence that may be available to show conception of the invention up to not more than two years anterior to the date of his original application. In this way an American inventor can spend several useful years perfecting his invention before his patent is granted, while the British inventor has often to watch the most useful years of his patent being eaten up in unproductive development.

I admit that the American system has drawbacks from the point of view of an industry, but it has certain undoubted advantages, and I suggest that the British system does not meet the needs of great inventions, between which and the ordinary minor inventions there ought in my opinion to be some discrimination. Merely as a suggestion, I see a possible solution in an extension of our present system of granting Patents of Addition, that is, a patent for an improvement on a prior patented invention, the Patent of Addition being granted during the lifetime of the original patent and running conterminously. If a Patent of Addition could be granted to an inventor in approved cases on production of evidence of genuine difficulties encountered and successfully overcome, these difficulties and their remedy to be fully described in the patent for the guidance of the industry, and if this Patent of Addition could be made valid for a definite term of years, one of the main fears of a patentee would be overcome.

It will be noticed that in this last suggestion I have stipulated that the specification of a Patent of Addition such as I suggest should contain not only a description of the finished invention but also of all the difficulties encountered in its production and the steps taken to surmount them. In fact, it is mainly for this reason that I make the suggestion at all. I am trying to devise a means to prevent future inventors and industry from being handicapped in a way that has been all too common in the past. I have already touched on what must be the large volume of valuable scientific information that has been lost through lack of records of past difficulties. Patent specifications are in many cases the sole record of inventions, yet in the cases of the type I have mentioned they tell us nothing of the difficulties, simply because the specification is written before the difficulties are encountered. I therefore suggest that if any additional protection be given to a patentee in virtue of work done in converting his invention into a practical mechanism in face of unsuspected obstacles, the grant should be absolutely conditional on his placing on public record for the guidance of others a complete history of his efforts so that no one may have to contend with the same troubles again.

I have one more suggestion to offer. On this question of assisting future inventors by increasing the store of knowledge at their disposal, I see a possible sphere of usefulness for the British Association and kindred institutions by encouraging the great inventors of to-day to place on record and publish through the medium of the Association or institution an account, even a brief one, of the main historical features of their inventions. If considerations of patents or of personal diffidence make it undesirable to publish these records at the time they are written, that need not impede the scheme, as publication could be made afterwards at a more convenient time or, say, after the inventor's death. The main thing is to have some authentic record from the inventor or discoverer himself recording the origin, growth, and development of his idea, the difficulties that beset him, and the manner in which they were overcome.

Nor do I think we should stop there. In my opinion too much attention has been paid in the past to success and too little to honest failure. It is one of our human frailties to look with something of contempt on the man who has failed to reach his goal, but this is not the attitude of the great minds, nor should it be the attitude of modern science. On one occasion Lord Kelvin was shown a report by a professor on a research carried out by a research scholar, in which the professor had made some rather contemptuous remarks on the results attained because these results were mainly negative. Kelvin was highly indignant. All he looked to was the fact that the young scholar had done his best on a subject which merited investigation and in face of undoubted difficulties, and it amazed him that any scientist should speak slightingly of the results, simply because they were negative, when the real thing of value was the earnest and diligent search after truth.

If, therefore, my suggestion be adopted by the

British Association, would it not be in the best interests of science to remember the failures as well as the successes, and to encourage all serious workers in important fields of research to furnish in the common cause a record of their work, even when their aim has not been achieved, giving a faithful account of all the difficulties and all the efforts made to surmount them? Who knows but that many of the so-called failures of yesterday may only be waiting for other hands to-day to carry them on to a greater success than the world has yet known? Left to themselves they will lie in oblivion, yet, for all we know, two of them may fit together and provide the answer to one more of the riddles of the universe.

Knowledge forms the working tools of science, and my proposal is in no way aimed at giving the scientific workers of to-morrow an easy task. They will probably have a far more difficult task than ours, but I do not think it fair to condemn them to spend part of their time in a preliminary and possibly fruitless search for tools which we have forged and hidden.

"As one lamp lights another, nor grows less," science of to-day will partly fail in its clear duty if it fails to pass on to to-morrow any of the knowledge which it has been privileged to acquire, or if it forgets that it is for to-morrow, rather than to-day, to assess the true value of to-day's success and failure.

Obituary.

Prof. W. Einthoven, For. Mem. R.S.

PROF. WILLEM EINTHOVEN, whose death on Sept. 28 at the age of sixty-eight years has been announced, was one of the foremost of modern physiologists. For nearly forty-two years he has been professor of physiology at Leyden, Holland, being invited to succeed Heynsius in November 1885, and actually taking up his duties, after passing his final State examination in medicine, on Feb. 24, 1886. For the first twenty years of his office the chair of physiology was combined with that of histology.

Einthoven was born in Semarang, in the Dutch Indies, where his father was in medical practice. After his father's death, his mother with her six children settled in Utrecht, where Einthoven was educated at school and as a medical student in the University. He spoke with gratitude of his teachers there, particularly of the physicist Buys Ballot, and then of the anatomist Koster, the ophthalmologist Snellen, and the physiologist Donders. His first scientific investigation was carried out with Koster on the mechanism of the elbow joint; he assisted Snellen both in private practice and in the clinic; and in 1885 his dissertation, "Über Stereoskopie durch Farbendifferenz," was approved by Donders for the degree of doctor of medicine.

Einthoven's investigations cover a wide range, but they are all notable for the same characteristic—the mastery of physical technique which they show. Einthoven, in spite of his medical training and his office, was essentially a physicist, and the extraordinary value of his contributions to physiology, and therewith indirectly to medicine, emphasises the way in which an aptitude—in Einthoven's case a genius—for physical methods can aid in the solution of physiological problems. His papers are published in the *Nederlandsch Tijdschrift voor Geneeskunde*, *Archives Néerlandaises*, *Archives Internationales de Physiologie*, *Brain*, *Quarterly Journal of Experimental Physiology*, *Annalen der Physik*, and especially in *Pflüger's Archiv für die gesammte Physiologie*. He wrote an article in Heymann's "Handbuch der Laryngologie und Rhinologie," and edited ten volumes of "Onderzoekingen Physiologisch Laboratorium, Leiden."

Einthoven's name is connected chiefly with the string galvanometer and the electrocardiogram. The potential differences involved in the electrical phenomena of the heart beat are fractions of a millivolt and occur in thousandths of a second. The problem of recording these small and fleeting changes, previously attempted without complete success with the capillary electrometer, was solved in 1903 by the invention of the string galvanometer; to-day there are hundreds, probably thousands, of these instruments all over the world, and they have been applied not only to their original purpose of registering the action current of the heart (and incidentally of muscles, nerves, and retina), but also to such diverse uses as finding the velocities of shells, receiving and recording wireless signals, and locating enemy guns; and I believe it is true that Einthoven never received any material profit from his invention. In 1909 he published the first complete description of the instrument, while in the last few years, employing fibres of almost ultra-microscopic size working in a high vacuum, he has succeeded, in collaboration with his son, an electrical engineer, in recording potential changes of frequencies of the order of 100,000 per second. It may be mentioned also that recently, by means of fibres of extreme thinness, he was able to register directly, and with very little distortion, sound waves of more than 10,000 vibrations per second.

Einthoven's most important work, for which he was awarded the Nobel Prize in 1924, was his discovery of the mechanism, of the manner of production, of the electrocardiogram and its characteristic waves. In many directions the diagnosis of maladies of the heart has improved in recent times, but the greatest single advance was made by Einthoven in applying the string galvanometer to the investigation of the electrical phenomena of the normal heart-beat. This work was followed up, particularly by Sir Thomas Lewis in London, and has resulted in a clearer understanding of the cause of some common disorders of the heart, and in improvement in their treatment.

Of the more personal side of Einthoven's life one might write of the grace, beauty, and simplicity of his character. He spoke with ease three languages as well as his own; he was a regular attendant at international gatherings; he threw all his influence on the side of good international relations in science. Last summer he was present at the International Congress of Physiology at Stockholm, and attended the various functions, and took part in many of the excursions, including a trip to the north of Sweden and back by sea along the Norwegian coast. It was a wonderful thing to be his guest and to enjoy the delightful hospitality of his home. He invited me some years ago, while we were attending a German congress of physiologists at Tübingen, to stay with him at Leyden on my way back to England. We arranged to meet at a station in North Germany and to travel the last part of the journey together. I waited until his train arrived. He came literally running along the platform to meet me, seized my bag out of my hand, carried it to the carriage, where he had kept me the best seat, and made me feel that whatever the difference of our age and position, I was from that moment his honoured guest. In 1924 we sailed together to America, and at night under the starlit sky we walked on the upper deck discussing the random movements of electrons in conducting fibres and other matters equally strange. These personal details will emphasise what a loss his passing will be, not only to his older colleagues and to his younger friends, but also to all the good fellowship of physiologists throughout the world.

Einthoven was elected an honorary member of the Physiological Society in 1924, and in return he invited the Society to hold one of its meetings in his laboratory. The occasion will be a happy memory in the minds of those who were able to go to Leyden in April 1925. In 1924 he visited the United States to deliver a course of lectures at Boston, and while there, the award to him of the Nobel Prize for medicine for 1924 was announced. He was elected a foreign member of the Royal Society in 1926. A. V. H.

Prof. Svante Arrhenius, For. Mem. R.S.

The annals of physical science bear abundant testimony to the native genius and energy of Sweden, and in this respect Svante August Arrhenius, who has just passed away, upheld with honour and distinction the reputation of his country. Born near Upsala in 1859, as the son of a land steward, Arrhenius obtained his early education in the school and university of that town, moving later to the University of Stockholm, the atmosphere of which was more congenial and stimulating to the young physicist. His researches there on electrical conductivity and its relation to chemical activity, although lightly esteemed by the Upsala professors, brought him recognition abroad, whilst the theory of electrolytic dissociation, put forward in 1887 during his *Wanderjahre*, secured for him an established position in international science.

During these *Wanderjahre*, with financial support provided by the Swedish Academy of Sciences, Arrhenius visited quite a number of active research centres. Thus he worked with Ostwald at Riga, and later at Leipzig (the laboratory which van 't Hoff in 1888 termed the 'Hauptagentur für Ionenspaltung'), with Boltzmann at Graz, with Kohlrausch at Würzburg, and with van 't Hoff at Amsterdam.

Refusing an invitation to settle at Giessen, Arrhenius returned to Sweden in 1891, and acted first as lecturer and afterwards as professor in the newly established Technical High School at Stockholm. Somewhat later he acted as Rector of the same institution for a number of years. Giessen was not the only foreign university which made an effort to secure Arrhenius, for in 1905 he was invited to Berlin. This honour was likewise declined, and in the same year he was appointed Director of the Nobel Institute at Stockholm. Arrhenius occupied this position up to the time of his death, and the numerous communications published by the Institute bear witness to the activity of this centre of research under his inspiring leadership.

Arrhenius was a frequent visitor to England, and although his scientific views met with a critical reception in various quarters, his genial and attractive personality made him always a welcome guest. His work secured extensive recognition from British scientific bodies, and he was a foreign member or honorary fellow of the Royal Society, the Chemical Society, the Physical Society, and the Royal Institution. Honorary degrees were conferred on Arrhenius by the Universities of Oxford, Cambridge, Birmingham, and Edinburgh, whilst the Royal Society awarded him the Davy Medal in 1902, and by invitation of the Chemical Society he delivered the Faraday Lecture in 1914.

In Europe and America also his international standing was marked by his election as corresponding member of numerous academies and learned societies, whilst honorary degrees were conferred on him by the Universities of Heidelberg, Groningen, Oslo, and Leipzig. Further, he was the recipient of the Nobel Prize for chemistry in 1903.

The honoured place which Arrhenius occupied in physical science was without doubt mainly due to his bold and original ideas on the condition of dissolved electrolytes, as expressed in his theory of electrolytic dissociation, and it is on this ground that he is justly regarded as one of the founders of modern physical chemistry. The genesis of this theory in Arrhenius's mind, on the basis of his own experimental work and in correlation with van 't Hoff's researches on osmotic pressure, is worth recalling, for it constitutes one of the most interesting chapters in the history of physical chemistry.

Investigation of the electrical conductivity of forty to fifty substances in dilute aqueous solution had led Arrhenius in 1883 to two striking conclusions: (1) that in regard to conduction of the electric current only part of the electrolyte is to be regarded as 'active,' this proportion increasing on dilution, and (2) that there is a parallelism between the 'strength' of an acid and its electrical conductivity. The conception of the 'activity coefficient' as a 'degree of ionisation' came later, and was not published until Arrhenius had become acquainted with van 't Hoff's memoir on the extension of the gas laws to solutions. The abnormal behaviour of dissolved salts, expressed by the van 't Hoff factor i in the equation $pv = iRT$, was precisely the point on which Arrhenius fastened as of special significance for his theory of dissociation. He writes from Würzburg to van 't Hoff under date March 30, 1887: "Die Abhandlung [*i.e.* van 't Hoff's memoir] hat mir nämlich in unerhörtem Grade Klarheit geschafft über die Konstitution der Lösungen," and he proceeds to the correlation of osmotic abnormality and ionisation. This correlation was the main feature of the communications made by Arrhenius in 1887 to the Swedish Academy, and of the classical paper "Über die Dissociation der in Wasser gelösten Stoffe," published in the *Zeitschrift für physikalische Chemie*. An early announcement of these new developments was made also to Sir Oliver Lodge as secretary of the British Association Committee on Electrolysis.

It was fortunate for the propagation of Arrhenius's ideas that he was in alliance with van 't Hoff, and that he had such an able and enthusiastic advocate as Ostwald. The newly established *Zeitschrift für physikalische Chemie*, run mainly by Ostwald, provided an effective platform for the discussion of the new theory and the relevant experimental investigations. Arrhenius's views evoked strong opposition in many quarters, but as the years passed the utility of this theory as a basis for the study of solutions *on quantitative lines* became more and more apparent. The theory stimulated a prodigious amount of research, and if modifications have been made and are still being made, the ideas of Arrhenius have nevertheless yielded an abundant harvest.

In the experimental investigation of problems suggested by the new views on solution Arrhenius himself, as well as his co-workers in the Nobel Institute, took a prominent part. Such matters as the diffusion of electrolytes, neutral salt action, the hydrolysis of salts, the catalytic activity of acids, isohydric solutions, were examined from the viewpoint of electrolytic dissociation, and the extent determined to which the new theory was capable of giving a quantitative account of each case.

The study of physiological and biological problems on quantitative physico-chemical lines was another field in which Arrhenius was active, both theoretically and experimentally. He concerned himself more especially with serum therapy, and many of his original papers and books deal with aspects of this subject, such as the relation of toxins and anti-toxins.

From serum therapy to cosmogony seems a long step, but the latter also was a subject in which Arrhenius was deeply interested, and the varied problems of which occupied much of his thoughts. The nature of planetary atmospheres, the genesis of the solar system, the origin of the aurora, the influence of carbon dioxide on the temperature of the earth, the function of light pressure, and the periodicity of certain natural phenomena were among the problems on which Arrhenius expressed fresh and original views.

The contributions of Arrhenius to serum therapy and to cosmogony were both striking and important, but without doubt the honourable and permanent place which his name occupies in the roll of men of science is due, not to his work in these two fields, but to the fresh impetus given by him to the study of solutions on quantitative lines. J. C. P.

The Right Hon. the Earl of Iveagh, F.R.S.

The Earl of Iveagh, who died on Oct. 7 in his eightieth year, distributed large sums for public objects. Consideration for the sufferings of others was one of his noblest characteristics, and his contributions to hospitals in Dublin and elsewhere were on a princely scale. When the Boer War broke out, he equipped the Irish Field Hospital, and during the Great War he spent vast sums in increasing the provision for our sick and wounded. Lord Iveagh was, however, a philanthropist embued with a spirit of social reform. The urgent appeal of sickness and suffering is responded to by many according to their means, but other of Lord Iveagh's repeated acts of benevolence indicate a considered scheme to increase the well-being by improving the health of the people.

In 1889, Lord Iveagh gave £250,000 for the substitution of sanitary dwellings for slums in Dublin and London. Nine years later he provided a similar sum to improve a congested and noisome area abutting on St. Patrick's Cathedral, Dublin. By this scheme the old dwellings and streets were done away with and a public garden of about two acres was provided around the Cathedral. Upon the rest of the seven and a half acres model dwellings for working people were erected, with a central play-hall for the children.

Prior to 1907 the congested state of the old markets in Dublin and the surrounding areas was not only an eyesore but also a serious menace to the public health. At this date Lord Iveagh bought up the whole area, built modern markets, and presented this valuable property to the city. He was, indeed, a practical hygienist, for there is no better means of improving the health of an urban population than providing it with good housing and opportunities to spend more time in the open air and sunlight. One of the latest of Lord Iveagh's benefactions was destined to increase the facilities for recreation in the open air of the citizens of London. In 1925 he purchased the residue of the Ken Wood property adjoining Hampstead Heath, which the Preservation Committee had been unable to acquire owing to exhaustion of its resources. The whole of this fine place of woodland now becomes public property.

The idea of furthering the public health by stimulating medical discovery seems to have originated in 1896 owing to an accident to one of Lord Iveagh's employees. A labourer upon his estate having been bitten by a rabid dog, he directed that everything possible was to be done for the unfortunate man, but was surprised to learn that the treatment for hydrophobia could only be secured by sending the patient to Paris. This was done, and no further ill results ensued; but the novelty of the treatment and the absence of facilities in England for the prosecution of researches such as had led to Pasteur's fruitful discovery made a deep impression on his mind. In 1898, Lord Iveagh visited the Pasteur Institute, and the project of endowing a similar institute in London began to take shape. Ascertaining that the Lister Institute (then the Jenner Institute) had been founded with the objects he had in view but was languishing for want of funds, he decided, after careful inquiry, to endow the Institute to the extent of £250,000, subject to certain alterations in its constitution and government.

Another institute for medical research, as well as the treatment of patients, which is largely indebted to Lord Iveagh's liberality, is the Radium Institute in Riding House Street, London. This was founded in 1909 to make researches upon the effect of radium on the human organism and to supply treatment to patients whose circumstances did not permit them to receive the benefit of radium treatment without financial help. The whole of the money required for the building, equipment, and endowment of the Radium institute was provided by Lord Iveagh and the late Sir Ernest Cassel.

Lord Iveagh made large benefactions for various purposes to his old college, Trinity College, Dublin, and built for it new Institutes for physics and botany, and endowed the school of geology. The new National University of Ireland also is indebted to him for a valuable site at St. Stephen's Green.

Even a complete list of Lord Iveagh's known gifts for public purposes would fail to record many of the benefits he dispensed. Partly from a distaste for notoriety, partly for self-protection, the hand of the donor was concealed. His philanthropic enterprises were carefully considered and evolved with patience and attention to details. He took a personal interest in all his schemes and often a large part in the direction of them.

In 1906, Lord Iveagh was elected a Fellow of the Royal Society under Statute 12 "as having rendered conspicuous service to the cause of science," and in 1908 he was unanimously elected chancellor of the University of Dublin.

We regret to announce the following deaths:

Dr. Charles C. Godfrey, president of the American Association of Variable Star Observers, conducted in co-operation with the Harvard Observatory, on Aug. 31, aged seventy-one years.

Dr. B. Daydon Jackson, secretary of the Linnean Society of London for forty-seven years, editor of the "Index Kewensis," and author of other important botanical works, on Oct. 12, in his eighty-second year.

Dr. William Libbey, professor of physical geography and Director of the Museum of Geology, Princeton University, from 1883 until 1923, on Sept. 6, aged seventy-two years.

Prof. Alexander Mair, professor of philosophy in the University of Liverpool, president in 1925 of the Association of University Teachers, and author of "Philosophy and Reality" (1911), on Oct. 8, aged fifty-seven years.

Dr. J. W. Mollison, C.S.I., formerly Inspector-General of Agriculture in India, who was the first head of the Imperial Agricultural Research Institute at Pusa, on Oct. 4, aged seventy years.

Dr. Eugene Allen Smith, emeritus professor of mineralogy and geology in the University of Alabama and state geologist since 1873, who was vice-president (Section E) of the American Association for the Advancement of Science in 1904, on Sept. 7, aged eighty-five years.

Mr. H. M. Taylor, F.R.S., senior fellow and formerly mathematical lecturer of Trinity College, Cambridge, distinguished by his contributions to mathematical science and his translation of many scientific works into Braille for use by the blind, on Oct. 16, at eighty-five years of age.

News and Views.

The amount of change a story can undergo through repeated copying is a commonplace of experimental psychology; and every scientific worker in the habit of verifying original references has met with examples where the actual statements of an early investigator differ substantially from the versions of them to be found in more recent writings. But it is not often that one meets so extreme a case as that given by Mr. Gheury de Bray in a letter to Nature of Sept. 17, and in an article in the present issue. Of eleven determinations of the velocity of light quoted in standard works, only one turned out to have been quoted correctly. Mr. de Bray's historical work should provide material for any one in need of examples for the precept 'Verify your references.'

In a paper in the *Astronomische Nachrichten* (No. 5520), Mr. de Bray has used what appear to be the best of the determinations, after due criticism, and has shown that they point to a decrease in the velocity of light of about 200 km./sec. in the last fifty years. As he says, however, the earlier determinations are not good enough individually to determine such a change, and his argument rests on the fact that they all agree in suggesting a change in the same direction. Of the seven determinations retained, one differs from 299,800 km./sec. by 2·2 times its probable error, one by 2·0 times, and the rest by smaller multiples. In a random set of observations 1 in 5 would deviate from the true value by more than twice the probable error. The velocity of light being so fundamental a constant, physicists may prefer to attribute any change in its measure, if established, to a change in the unit of velocity and not to one in the velocity of light itself. The variation of the second is shown by E. W. Brown's recent work to be within a few parts in 10^7. The possibility of measurement of wave-lengths within a few thousandths of an

Ångström unit indicates that the unit of length is equally constant. We can, therefore, scarcely admit such a change in the unit of velocity as would be needed to account for a change in the measured velocity of light of the order of one in a thousand. An absolute change in the velocity of light, on the other hand, could scarcely obtain acceptance unless supported by much more decisive observational material.

An international conference on the Protection of Migratory Wild Fowl was opened, under the presidency of Lord Ullswater, at the Foreign Office on Oct. 12. The conference is the successor of two preliminary meetings, held in 1924 in Sweden and in 1926 in Copenhagen, at which the need of action for the protection of wild ducks, geese, swans, and similar migrants was strongly urged by the representatives of northern European countries. The Governments of the countries concerned were favourably disposed towards the views expressed at the earlier meetings and the invitation of the British Government was accepted by the following Governments, which are officially represented: Germany, Belgium, Holland, Denmark, Sweden, and Finland, as well as Great Britain, with Dr. P. R. Lowe and Mr. H. S. Gladstone as delegates. The discussions of the early sessions of the conference centred round the altered status of migratory wild fowl in recent years. Delegate after delegate reported that migratory wild fowl were on the decrease, and this view so impressed the conference that it passed a resolution stating that in its opinion there had been a general diminution in the number of migratory wild fowl, and that "in the interests of agriculture, science, sport, the maintenance of the food supply, and the desirability of retaining natural species of beauty and interest, it is imperative that steps should be taken to arrest such diminution." Various suggestions were made as to means best suited for reaching this end, the extension of the close season, the prohibition of the slaughter of migratory wild fowl on the northward migration to the breeding grounds in spring, the prohibition of mechanically-propelled boats, of clap nets, standing nets, sunk nets, and so on; and the conference blessed them all, and added a resolution recommending the most effective protective instrument of all, that the *sale* of migratory wild fowl should be forbidden during the close season except under rigid conditions. It will be interesting to see what international legislative action follows upon the unanimous recommendations of the ornithologists.

At the recent International Optical Congress held at Oxford, considerable discussion was devoted to the question of the importance of good vision for all persons licensed as motor drivers. In this matter, keenness of visual acuity is not the only or even the prime consideration, since, when outdoors, one is looking at relatively large objects. The really important things are limitations in the extent of the visual fields, and the further question of binocular vision and latent imbalance of the muscles controlling the eye movements. Limitations in the visual fields do provide a dangerous disability for the driver of any fast moving vehicle, since whilst his attention is directed straight ahead, he should still be capable and keen to detect the slightest movement (even if associated with some vagueness of form) of any other moving person or vehicle issuing from side streets or lanes into his main sphere of attention, that is, into his central field of vision. With regard to faults in the co-ordinated balance of the two eyes—which would interfere with binocular vision—it is well known that perception of depth and judgment of distance are both almost entirely attained by perfect stereoscopic or binocular vision. Any person, therefore, who is deprived of this faculty, is liable to misjudge distances, and there is no doubt many accidents are caused by drivers suffering from such a visual deficiency which led him to believe that he might just clear some imminent obstacle, when in reality the actual distance away from that obstacle was much less than it appeared to be. Such defects are much more dangerous to the rest of the public than the commoner visual defects of long-sightedness or even low degrees of myopia.

Another question of public interest to which considerable attention was given at the recent International Optical Congress was that of visual efficiency in industry. This is undoubtedly a problem of some complexity, since in British industrial circles there is still some prejudice against the worker wearing spectacles. In a great many workshops there is yet the old shibboleth prevailing that the wearing of glasses is a sign of the oncoming of old age, and definitely marks another prospective victim for the human scrap-heap. There is no reason why such a prejudice should still prevail, since it is obvious that the worker will produce better and finer work—with greater accuracy, fewer flaws, and less wastage, if steps are taken to ensure that he is visually efficient. It was reported that in some large manufactories, schemes had already been brought into operation whereby the eyes of all the workers were examined and any defect was corrected. Statistics prove that in all cases such provision had resulted in a large increase of efficiency in production and increased good health and pleasure on the part of the operative.

A further point of importance which is regularly overlooked in various trades lies in the fact that many operations are carried out at an abnormally short working distance, and in such cases—even if the operative's sight is perfect for ordinary purposes—there should be some assistance provided in the form of spectacles in order to prevent undue fatigue, headache, and the possible cultivation of more permanent defects. Such a condition of affairs is well illustrated in the process known as 'linking' in the hosiery trade, which was the subject of a special pamphlet recently issued by the government Department of Scientific and Industrial Research. Compared with the United States, there is comparatively little attention devoted to this subject by British employers. The fact that it has been proved by individual firms in such trades as printing, and in such industries as the textile in many of its branches, that both financial advantage and increase of output is a consequence of giving attention to the vision of the worker, it is to be hoped that more general attention will be paid to the question in the immediate future.

We have already referred to the movement to establish in the Central Reference Library of Southwark a Faraday Memorial Collection, consisting of the biographies, portraits, and published works of Faraday, and the best and latest books on the sciences and their applications, particularly electricity, with which Faraday's name is so closely identified. The Mayor of Southwark invites contributions to the Faraday Memorial Fund being raised for this purpose. The annual income will be expended year by year under the direction of a special Committee exclusively for the object in view. The use of the Faraday Memorial Collection will not be limited to local residents but, like the benefits of Faraday's discoveries, will be available for all who desire to consult it. The memorial is to be inaugurated by Sir Oliver Lodge on Oct. 28. It is hoped that generous support will be forthcoming to the fund being raised. Contributions should be sent to the Mayor, Southwark Town Hall, Walworth Road, London S.E. 17. Contributors to the memorial, without regard to the amount subscribed, will be enrolled as foundation donors.

A committee to inquire into the organisation, development, and recruitment of the Colonial Veterinary Services has been appointed by the Secretary of State for the Colonies. The committee is asked to frame proposals for obtaining the highest degree of efficiency in regard to veterinary research and administration in the non-self-governing Dependencies that financial considerations permit. The questions to be considered will embrace the recruitment and training of veterinary officers, their conditions of service, the organisation of research and intelligence, the setting up and support of any institutions required, and methods by which the financial expenditure involved can best be met. In framing its recommendations the committee has to bear in mind that the principle of the ultimate creation of a Colonial Scientific and Research Service has been approved by the Colonial Office Conference, and that specific proposals for the formation of an Agricultural Scientific and Research Service for the non-self-governing Dependencies, with which the veterinary service must necessarily maintain close liaison, are now being framed. The committee consists of: Lord Lovat (Chairman), the Right Hon. W. Ormsby-Gore, Sir Arnold Theiler, Prof. J. B. Buxton, Prof. R. T. Leiper, Dr. W. H. Andrews, Dr. J. B. Orr, Mr. W. C. Bottomley, and Major R. D. Furse, with the addition of an officer with experience in the Colonial Service. Major G. S. M. Hutchinson, Colonial Office, is secretary to the committee.

In Great Britain, while there are evident the most divergent attitudes towards the problem of birth control, there is no organised attempt to make discussion or propaganda illegal. It is not widely known that in other countries such attempts are being made, and that in certain countries they have been successful. It may, therefore, be of some interest to give a brief résumé of the position stated in a detailed communication received from Dr. Marie Stopes. The American Comstock Law was originally designed to prevent the sending by post of indecent pictorial postcards and similar matter. During its progress into law obscene matter was defined so as to include any directions, drugs, or articles for the prevention of conception, and it is now an offence punishable by a 5000 dollar fine, or five years imprisonment or both, to send birth control information by post. The French Law of 1920 is more comprehensive. It punishes by one to six months' imprisonment, and a fine of from 100 to 5000 francs, any one who explains or offers to explain birth control methods, or devotes himself to contraceptive propaganda, or propaganda against childbirth. Similar steps have been taken in other countries. The present position, however, is not easy to ascertain, because the measures often assume the form of extending by administrative order the definition of obscene publications, with the result that in certain countries, Belgium and Canada, for example, publications having reference to contraception are seized by post office or custom house officials, or both. A Committee appointed by the Minister of Justice of the Irish Free State recently reported in favour of an amendment of the Indecent Advertisements Act so as to make illegal the sale of literature concerning contraception..

Attention was directed in Nature of July 9 last to the popularly written leaflets on astronomical matters issued by the Astronomical Society of the Pacific. Two further leaflets belonging to the series have now come to hand, bearing the titles "Exploring the Depths of Space" and "The Pons-Winnecke Comet," and others are in course of preparation. In addition, the Society (the address of which is 803 Merchants Exchange Building, San Francisco, California) has, for the last two or three years, arranged series of illustrated popular lectures in San Francisco on various aspects of astronomical research and discovery, delivered by astronomers of repute, to which the public are admitted free of charge. Leaflets containing syllabuses of the lectures have been issued, at the backs of which are collected useful astronomical data and, in some instances, diagrams of the night sky at various times during the year. During the present session, for example, a series of four lectures will be given by Dr. Wm. F. Meyer, assistant professor of astronomy in the University of California, on the general subject, "From Atom to Island Universe," the titles of the individual lectures being "The Atomic World," "The Interior of a Star," "Island Universes," and "The Night Sky of Winter." An annual visit to the Lick Observatory is conducted by the Society, in connexion with which pamphlets are issued containing information relating to the most interesting objects visible at the time. We hope that a large measure of success will attend these praiseworthy efforts for the popularisation of astronomical knowledge. It is perhaps not generally understood that membership of the Society, including the receipt of all publications and privileges, is open to all, irrespective of nationality or astronomical qualifications.

THE Council of the Iron and Steel Institute has awarded the Carnegie Gold Medal for the year 1925 to Mr. A. L. Curtis, Westmoor Laboratory, Chatteris, in recognition of his research work on steel moulding sand, etc.

THE Thomas Hawksley lecture of the Institution of Mechanical Engineers, on "Application of X-rays to the Study of the Crystalline Structure of Materials," will be delivered by Sir William Bragg, on Friday, Nov. 4, at 6 o'clock P.M.

SIR WILLIAM LARKE, Director of the National Federation of Iron and Steel Manufacturers, has been appointed by Order of Council dated Oct. 5, 1927, to be a member of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research.

MR. F. J. BLIGHT, who since 1894 has been associated with the well-known firm of scientific and technical publishers, Messrs. Charles Griffin and Co., Ltd., and has been head of that house since 1899, is retiring from that position. Many authors of scientific and technical works published by Messrs. Griffin appreciate the valuable services rendered by Mr. Blight to the production of specialised works on important aspects of modern science and industry, and trust that there are still before him further years of useful life and influence even in his retirement.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A lecturer in building trades and a lecturer in furniture trades in the Technical College, East London, South Africa—The Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (Oct. 31). A research chemist for work on plasters and other materials used for impressions and models in dentistry—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (Nov. 7). An engineer for the Sanitary Department, Buildings and Roads Branch, Government of the Punjab—The Secretary to the High Commissioner for India, General Department, 42 Grosvenor Gardens, S.W.1 (Nov. 10). A demonstrator in physiology at St. Bartholomew's Medical College—The Dean, Medical College, St. Bartholomew's Hospital, E.C.1 (Nov. 16). A chief lecturer in chemistry at the Woolwich Polytechnic—The Principal, Woolwich Polytechnic, S.E. 18. A naval architect for the Marine department of the Government of Nigeria—The Crown Agents for the Colonies, 4 Millbank, S.W.1 (quoting M/6). A junior technical officer in an Admiralty experimental establishment, mainly for experiment and design in connexion with wireless and other electrical apparatus—The Secretary of the Admiralty (C.E. Branch), Whitehall, S.W.1. A principal of the Massey Agricultural College, New Zealand—The High Commissioner for New Zealand, 415 Strand, W.C.2.

Our Astronomical Column.

MAGNETIC 'STORM' AND SUNSPOTS.—On Oct. 12, at $10\frac{1}{2}^h$, a considerable magnetic disturbance commenced and lasted until 2^h on the following morning. The chief characteristics as shown by the declination magnetograph records at Greenwich were, first, the sudden commencement; and secondly, the occurrence between 18^h and 21^h of three distinct waves of magnitude about 30′, 25′, and 40′ respectively. The total range in declination throughout the disturbance was about 1°. A lesser disturbance, of interest on account of its sharp commencement, also took place between Oct. 9, $20\frac{1}{2}^h$ and Oct. 10, 23^h.

At the time of the phenomena there were three groups of sunspots within a short distance of the sun's central meridian, as follows:

	Central Meridian Passage.	Latitude.	Area on Oct. 9.	
1.	Oct. 9·4	19° N	300	Millionths of sun's hemisphere.
2.	Oct. 10·6	12 S	500	
3.	Oct. 11·6	19 S	250	

Both (2) and (3) were returns of large groups, conspicuous in the previous rotation, to which attention was directed in NATURE of Sept. 24, p. 456. A large area of bright faculæ surrounded these two groups of which (2) showed marked changes after Oct. 7, when new spots appeared. A connexion may reasonably be attributed between this group of spots and the magnetic 'storm' of Oct. 12.

METEOR SHOWER OF GIACOBINI'S COMET.—Mr. W. F. Denning writes that "two observers watched the sky from Bristol on Oct. 8, 9, and 10 from about 6.30 P.M. to 9.30 P.M., though the moon was near the full and some fog prevailed. The object was to observe a few meteors from Giacobini's comet, the orbit of which lies near the earth's path on Oct. 9–10. It may be remembered that last year a definite shower was witnessed on Oct. 9 with a radiant agreeing with that computed for the comet named. Owing to the unfavourable conditions, few meteors were noticed this year, but on Oct. 8 about eight were seen and ten on Oct. 9. A fine flashing meteor was seen on Oct. 8 at 7.56 P.M. in the south-west, but it could have had no association with Giacobini's comet. On Oct. 9 seven meteors were recorded, which showed diffuse radiation from 260° + 53°, and there is little doubt that this shower represented a return of the display of 1926, as the date agrees and the position of radiation, in the head of Draco, nearly coincides. No doubt the display would have been more abundant and the individual objects more brilliant but for the fog and moonlight which made the circumstances extremely unfavourable."

PHOTOMETRY OF THE MOON'S SURFACE.—*Astr. Nach.* No. 5524 contains observations of the albedo of various regions of the moon, made by A. Markov at Pulkovo. The observations were photographic on Agfa plates. Photographs of stars and of a standard lamp were taken for comparison. Aristarchus is the region of highest albedo, the value being 0·37, Tycho and Proclus coming next. It will be noticed that the value is far below that for snow, which some had suggested as possibly present on the brighter regions. The darkest regions are Schickard and Grimaldi with values 0·09 and 0·07. The mean albedo of the disc is about 0·16, in good agreement with former determinations.

Research Items.

Cave Exploration at Lespugue, France.—Cultural and chronological relations of some importance have been established by excavations in the Grotte de Gouërris at Lespugue, which have been carried out by M. le Comte de Saint Périer, and are described by him in *L'Anthropologie*, T. 37, Nos. 3-4. The cave was first discovered by Miss D. Garrod. When excavated it was found to contain three levels of occupation. Of these the latest was neolithic, when the cave was not used as a dwelling-place but solely for purposes of burial. Traces of fire have been discovered, which probably points to the preparation of funeral feasts in the cave. No signs of the habitation-sites of the people using the cave for burial purposes have been found in the neighbourhood. Of the two preceding occupation levels, the earliest was that of a palæolithic people, who, it is suggested, made no prolonged stay. Probably they were hunters following the herds of reindeer of which the remains are abundant. They belonged to an early stage of the Magdalenian epoch when the harpoon was still unknown. They appear to have been related to the population of Perigord rather than that of the Pyrenees. After a period which allowed of a considerable deposit of stalagmite, they were followed by a people of low culture. The climate by then had become warmer and more moist. This people, as is indicated by their culture, belonged to the very beginning of the transition period. There are many Magdalenian types of implement. The harpoons are not of the typical Magdalenian style, yet they have not yet attained the Azilian form with teeth on both edges. A comparison with Mas d'Azil establishes the position of this culture as between the latest Magdalenian stratum at Mas d'Azil (Couche *D* of Piette) and the stratum *E* in which the coloured pebbles and the full-fledged Azilian culture were found. Thus Piette's contention that the large flat harpoon with unilateral barbs belonged to quite the beginning of the transition period is not only supported but also is given greater precision in date.

Criminal Statistics.—Statistics relating to criminal proceedings, police, coroners, prisons, and criminal lunatics for the year 1925, have recently been published (London: H.M. Stationery Office. 4*s*. net). Not only are the actual figures given for the period surveyed, but also comparative tables and graphs, so that the 'peak' periods and the variations at different periods can be studied. Allowance has of course to be made for the increase in population by about seven millions since 1899: it is suggested that the safer figure for comparative purposes is the proportion the indictable offences known to the police have borne to every 100,000 of the estimated population. The crime rate would seem to have fallen since 1857: for the period since 1899 the worst year is 1908. Here would appear to be reflected the effect of the Boer War. Six years after this war the increase in indictable offences was checked, and it is hoped that the similar increase since the War of 1914–18 will also be arrested. While there has been a tendency for the number of homicides to decrease in number, crimes against property, *i.e.* burglary, etc., have increased during the period 1899–1925. The volume will be of very great service to all those interested in social conditions, as well as to those officially concerned with the problems involved.

Quantitative Methods in Geography.—In an attempt to test and compare the intelligence of communities, Prof. E. Huntington has utilised the census figures showing the number of persons of various ages in the American States. Arguing that these figures should show a steady decrease from one upwards and so be represented, when plotted, by a smooth curve, he shows that the curves are extremely irregular in many of the States where negroes are numerous. This he maintains is due to carelessness or ignorance. The age of the children is forgotten or merely stated in a round figure in order to save trouble. Several of these curves are produced in an article in the *Scientific Monthly* for October entitled "The Quantitative Phases of Human Geography." Prof. Huntington has also compiled a map of the United States showing accuracy of census returns as to age based only on native whites of native parentage in order to eliminate, so far as possible, questions of race. This map shows the highest degree of accuracy in the northern States, with a steady falling off towards the south and especially the south-east, except for Florida, where recent migration from northern States has been marked. In Nevada the standard is low, probably due to the decay of the mining industry and the drifting away of the more intelligent classes. The paper also contains other maps compiled from census statistics.

Limnology in California.—The region in which Stanford University lies, the Santa Clara Valley, California, owing to its brief rainy season, is dependent throughout the summer on irrigation. The university supply is from a small artificial reservoir $\frac{3}{4}$ mile long and $\frac{1}{4}$ mile wide, the Searsville Lake. Dr. Flora M. Scott has recently carried out a preliminary survey of this lake ("Introduction to the Limnology of Searsville Lake," *Stanford University Publications*, University Series, Biol. Sci., vol. 5, No. 1, 1927, pp. 1-83). According to Whipple's classification, this is a 'tropical' lake, the surface temperature never falling below 4° C. The greatest depth does not exceed 7 m., and circulation is therefore ensured. The plankton content is, however, temperate in character and shows a seasonal rotation of sub-arctic to sub-tropical forms in the course of the year. The Bacillarieæ as a group culminate in the spring, the Chlorophyceæ and Cyanophyceæ give rise to the summer maximum, while flagellates persist throughout the entire season. In the summer of 1924 the level of the lake became so low that the fish died off, and for hygienic reasons the lake had to be drained. Opportunity was then taken of carrying out some culture experiments with the dry surface mud from the lake bottom. If the solutions were kept acid (*p*H 5) no plankton organisms could be cultured from the mud samples, but under alkaline conditions the plankton soon became abundant. When the cultures were maintained at a temperature of approximately 34° C., the blue-green alga Oscillatoria alone succeeded in thriving.

Fresh Water Biology in Norway.—In 1905 the Academy of Science in Oslo received, by will, an estate from Herrn Direktor F. O. Guldberg on condition that a biological research station was set up. The first aim was by means of farming to secure a fund; and in 1925 sufficient had accumulated to buy a property on the Hurdals-See for which a boat-house, motor-boat, etc., were provided. In a recent report Prof. H. H. Gran and Miss Birgithe Ruud give some preliminary results ("Über die Planktonproduktion im Hurdals-See," *Vidensk. Acad. Oslo I. Mat.-Naturvid. Klasse*, 1927, No. 1, pp. 1-33). The Hurdals-See is a lake of average depth and of the type with stagnation in the bottom water in summer and winter, and vertical circulation to the bottom in spring (May) and autumn (November). The discontinuity layer lies in summer between 10 m. and 25 m. Lowering leaves of *Ranunculus aquatilis peltatus* in bottles to different depths, and noting the oxygen exchange, showed that the point at which assimilation equalled respiration lay between 6 m. and 8 m. For diatoms and brown flagellates this depth was greater. Quantitative investigations of the centrifuge plankton showed that whereas the flagellate *Dinobryon sertularia* had a summer maximum in June, all other species increased slowly throughout summer, reaching a maximum in September. The chief forms were *Tabellaria fenestrata, Cyclotella comta, Melosira distans,* and *Staurastrum jaculiferum.* As regards quantity of phytoplankton, the Hurdals-See does not differ essentially from most lakes in central Norway. It is, according to Naumann's designation, an ' oligotroph ' lake.

Amphioxus.—Dr. V. Franz of Jena has given in "Die Tierwelt der Nord- und Ostsee" (Leipzig: Akademische Verlagsgesellschaft, 1927, Lieferung 8, Teil XII. b, "Branchiostoma") an account of Amphioxus which is a beautiful little monograph in itself. *Branchiostoma lanceolatum,* as Amphioxus is now called, is the only European representative of the class Acrania, which altogether includes about a dozen species. This is, however, the only really well-known form which both on account of its primitive vertebrate character and its comparative accessibility is beloved of all zoologists, and an enormous amount of literature has been amassed dealing with this single animal. From the collection Dr. Franz has sifted out the interesting and important, and made a most useful summary, anatomical, embryological, and physiological. He is well equipped for undertaking such a work, as he has himself made considerable contributions during the last few years to the minute anatomy and behaviour of Amphioxus, including studies of the methods of movement, reactions to light and researches on the sense organs and sense cells.

The Lung-worm and the Stomach-worm of the Cat.—Dr. T. W. M. Cameron (*Jour. of Helminthology,* June 1927) has investigated the life history of the lung-worm and of the stomach-worm of the cat. The former, *Ælurostrongylus abstrusus,* lays its eggs in the alveoli and in the parenchymatous tissue of the lungs and there the larvæ hatch, pass up the trachea, are swallowed and pass out with the fæces. A description is given of the morphology and biology of the larva. When infected fæces are eaten by mice the larvæ migrate from the stomach of the mouse to the muscles and subcutaneous tissue where they encyst, and within three weeks develop into the infective stage, which may remain viable in the muscles for at least a year. If an infected mouse is eaten by a cat the larvæ escape from their cysts, reach the lungs, and within six weeks become mature adults. The stomach worm, *Ollulanus tricuspis,* lives on the surface of the gastric mucosa and in the acini of the glands. The first-stage larva emerges from the egg in the uterus of the worm and moults there. The second-stage larva develops into the third-stage larva which is found outside the parent worm, but the exact period at which it left the parent was not determined. This larva leaves the stomach of the cat in the vomit (and possibly in other ways, though no other has been discovered) and is swallowed by a new host in which it develops into the fourth-stage larva and finally into the adult. The characters of these four larval stages are described and figured. Hitherto it has generally been accepted that *Ollulanus tricuspis* had a complex life history requiring an intermediate host—the mouse. This view arose through the confusion of the larvæ of Ollulanus and Ælurostrongylus. Leuckart found larvæ in the cat and the mouse which he believed to be those of Ollulanus, but they were really larvæ of Ælurostrongylus.

The Boring Unionid of Assam.—The distribution and habits of the remarkable boring unionid, at first referred in 1836 to the genus Anodonta, but now known as *Balwantia soleniformis* (Benson), have lately received the attention of Dr. Sunder Lal Hora (*Jour. Proc. Asiatic Soc. Bengal,* vol. 21). Owing to its retiring habits it has been greatly overlooked, but Dr. Lal Hora is confident that it will prove widely distributed in South Cachar and several other places in the Surma valley. The animal lives in inclined burrows excavated in hard blue clay or in friable sandstone, after the manner of marine boring molluscs. The burrow is of uniform calibre throughout and its cross section corresponds with that of the shell, but is a little larger, while its length is about two inches more. The bivalve is anchored to the far end of the burrow by its foot, by the expansion and contraction of which it can move to and fro in the burrow, and thus by the aid of the coarse ridges on the shell enlarge its tenement at will. There is no proof that the young animal starts a burrow *de novo*: it probably takes possession of some pre-existing hole or crack and enlarges it as required. The mollusc is considered a great delicacy by the Uriya coolies, who have an ingenious way, that is fully described, of extracting it from its crypt.

Afforestation in Michigan.—Those interested in the afforestation work proceeding in Britain should read the *Special Bulletin* (No. 163, June 1927) on "Forest Planting in Michigan" by Alfred K. Chittenden of the Michigan State College of Agriculture. Planting work experiments have apparently been undertaken during the past thirty years at this institution. The present-day problem of the United States in connexion with timber supplies is well known and has been alluded to in Nature on several occasions during the past year. The position of the several individual States in the matter is therefore not without considerable interest in Europe. The author writes, "One of Michigan's greatest problems is that of replacing her forests. This is becoming increasingly important as the timber of the United States as a whole is being cut." Nature, he says, if given a chance will restore the forests of her own accord, but this is a slow process; nor will the composition of the second growth consist of the most valuable species. If these latter are required, planting must be resorted to. The author regards the matter from a different view-point to that usually accepted in Europe. "Although trees," he says, "will grow on the poorest soils, they, like farm crops, will do better on richer soils. So, while the forests will probably ultimately be confined to the poorer classes of soils which will not be needed for agriculture, it is better to plant forests in the meanwhile on the best lands available for the purpose." This may be the correct solution at the present time in a country where extensive areas of land are available, but would scarcely be applicable in England where the growth of food crops on all lands of suitable quality must be a first desideratum. The brochure is mainly confined to and intended for the planting of wood lots on farms. In several sections it deals with the questions of raising trees from seed in the nursery, the season to plant, field planting with costs, soil requirements, and the suitable species to make use of both from the point of view of soils and the uses to which the material grown can be put. Brief descriptions of the species advocated are given. The *Bulletin* concludes with a note on the afforestation of sand dunes and the method of planting windbreaks and shelter-belts.

New Eocene Mollusca from Texas.—An interesting paper on some new species of Mollusca from the Claiborne and Wilcox groups of the Eocene of Texas comes from the pen of Julia Gardner (*Jour. Washington Acad. Sci.*, vol. 17). Twenty-one new species and subspecies are described and figured on four excellent plates. The only freshwater form recorded belongs to the genus Planorbis, which has not been previously reported from the Eocene of Texas, and is represented by *P. andersoni*, n. sp. It is fairly common at the single locality where it was found.

New Silurian Pelecypod (Pycnodesma) from Alaska.—Mr. Edwin Kirk places on record a new pelecypod genus, Pycnodesma, from the Upper Silurian of Alaska (*Proc. U.S. Nat. Mus.*, vol. 71, art. 20). It is a large massive shell, sometimes attaining a size of 12 inches across and upwards of 2 inches in thickness at the umbonal region. The author refers it to the Megalodontidæ and compares it with Megalodon and Megalomus, from both of which it differs in its hinge characters. His figure of the hinge shows its peculiar features, which are such as to raise the question whether, possibly, this new genus may not be an ancestral form of his earlier described Devonian Tanaodon (Nature, vol. 120, July 2, 1927, p. 25), although the author himself does not make the comparison.

Discharge Phenomena.—Important quantitative contributions to the theory of glow discharges have been made by Prof. K. T. Compton and Mr. Morse in the September number of the *Physical Review*, and by Dr. J. Taylor in an Utrecht thesis presented on Sept. 28. The former have deduced a relation between the cathode constants of a discharge which is just self-maintained, and Prof. Townsend's 'ionization constants' for the gas. The new feature in their work is the use of the principle that the fields within the tube must be distributed so that there shall be a minimum dissipation of energy; Poisson's space-charge equation does not occur in the main analysis. Their predictions are verified as well as can be expected from the present meagre experimental data. Dr. Taylor has been more concerned with the initiation of the discharge, where he has been able to correlate the sparking potentials with the normal current-voltage curves, and those obtained when the supply of energy is restricted externally.

Stereographic Survey.—In the *Geographical Journal* for September, Major K. Mason describes, with maps, the results of his experiments in the Shaksgam with the Wild photo-theodolite. The instrument proved most satisfactory and the criticisms that are offered refer only to minor points of design and very superficial matters. The tests included an area already within the planetable survey of India, an area at the edge of the survey, to ascertain the value of the instrument for long distance reconnaissance survey, and an area without any control points identified for certain to find the limitations of the method for the revision of old maps. The plotting of the photographs was done on the Wild Autograph, which is designed to plot and contour four pairs of plates taken with the photo-theodolite. Mr. A. R. Hinks describes this machine and explains its principles in the same issue. The method has proved so successful that the Swiss Federal Topographical Survey has decided to use it in the re-survey of the whole of Switzerland.

Measuring Quartz Fibres.—In the October issue of the *Journal of Scientific Instruments*, Messrs. G. A. Tomlinson and H. Barrel, of the National Physical Laboratory, describe the two methods they have used for measuring the diameters of fine quartz fibres. If the fibre is placed in a parallel beam of white light and the deviations of the coloured bands seen on each side of the fibre are measured, then, on the theory that the fibre acts as a slit, its diameter can be calculated. Owing to reflection and refraction at the fibre, the results are not very accurate, but the method provides a simple means of testing the uniformity of the fibre by observing the bands as the fibre is moved along parallel to itself. The more trustworthy method is to clamp the ends of the fibre so that it is horizontal, and to hang a weight of about a milligram to its centre and measure the sag. The elasticity of quartz is taken as $5 \cdot 18 \times 10^{11}$ dynes per sq. cm. The arrangement is that adopted to determine the breaking stress in wires by s'Gravesande, "Physices Elementa Mathematica" (1742).

A Mechanical Maxwell Demon.—Small particles are notoriously more difficult to examine when they are neutral than when they are charged, and although the distribution of velocities amongst groups of electrons and ions has been analysed frequently, it has hitherto been impracticable to do this satisfactorily for ordinary gas-molecules. A considerable advance in this direction is described by J. L. Costa, H. D. Smyth, and K. T. Compton in a recent paper in the *Physical Review* (vol. 30, p. 349). A shaft carrying two slotted wheels was rotated at high speed within a stout metal container, the space between the wheels being evacuated by a powerful diffusion pump. Gas was fed into a lateral chamber, and those molecules the velocity of which had the appropriate relation to the speed of rotation and to the geometry of the apparatus, passed through gaps in both wheels and fell on the vane of a delicate radiometer. When the deflexion of the latter was plotted as a function of the rate of revolution, curves were obtained which agreed with those predicted on the assumption that the molecules had a Maxwellian distribution of velocities. The experiments were, however, difficult—in particular, the radiometer had to be used almost at the limit of its sensitivity—and it is unfortunately not yet possible to obtain the 'velocity spectrum' which was the original aim of the investigation.

The Ignition of Gases by Hot Wires.—A recent publication (Paper No. 36) of the Safety in Mines Research Board (London: H.M. Stationery Office, 1927. 1*s.* net) contains an account of a research carried out to discover whether the glowing filament of a two-volt miner's electric lamp-bulb might cause the ignition of mixtures of firedamp and air and thus constitute a source of danger in a coal-mine. The tungsten filaments of bulbs of recent manufacture burn at a high temperature (about 1500° C.) and, if breaking the glass did not fracture the filament, were found capable of igniting mixtures containing not more than about 12 per cent. of methane. With platinum wire of a given diameter, ignition can only occur within a narrow range of current, below which flameless surface combustion takes place. Above this limit, the wire fuses without igniting the mixture, providing it is less than 0·1 mm. in diameter. Heated tungsten wire, however, oxidises rapidly in the presence of oxygen, the temperature increasing until the metal burns with a bright flame of short duration but high temperature. This flame causes the ignition of firedamp. It is therefore recommended that the lamps should incorporate an automatic circuit-breaker operated by breaking the outer protecting glass.

The University of Bristol.

NEW PHYSICS LABORATORY.

THE University of Bristol not only owes its foundation to a member of the family of Wills, but also has since received a series of princely gifts from his two sons, Sir George and the late Mr. Henry Herbert Wills. Of these none is more striking than the Henry Herbert Wills Physics Laboratory, formally opened on Oct. 21 by Sir Ernest Rutherford before a distinguished company of physicists and of supporters of the University in Bristol and the surrounding counties. The laboratory through which Bristol may be expected to become increasingly important as a centre of physical research and teaching has arisen as the result of a gift of £200,000 presented in the years 1919–20. Mr. Wills desired that this gift should be used mainly in the erection of the building and that the interest accruing in the meantime should provide for its scientific equipment and go towards the establishment of an endowment fund for its maintenance.

The building as designed is the first instalment of an extensive scheme of University buildings intended by the donor to crown the top of a hill overlooking the city, and to be a distinctive feature in distant views of the city. Until the whole scheme has been developed, either as Mr. Wills intended or on somewhat similar lines, the meaning of the design of this first unit, with its tower and reversed "L" shaped plan, cannot be fully grasped.

The long arm of the "L" is arranged with the view of future extension; pending this, an external iron staircase is provided at its end. It contains four floors, together with one large and one small cellar completely underground. In general the rooms are arranged in units or multiples of units, in width 17 feet between centres. On the north side of the corridors most of the rooms are 26 feet deep, and on the south side 16½ feet deep. The ferro-concrete floors have intermediate support on a single row of concrete pillars axially central in the building. The building is designed more or less as a shell, and internal divisions may be removed or rearranged as required.

The general scheme of this portion of the building is subject to alteration in later years as the work of the laboratory develops. At present it is as follows:

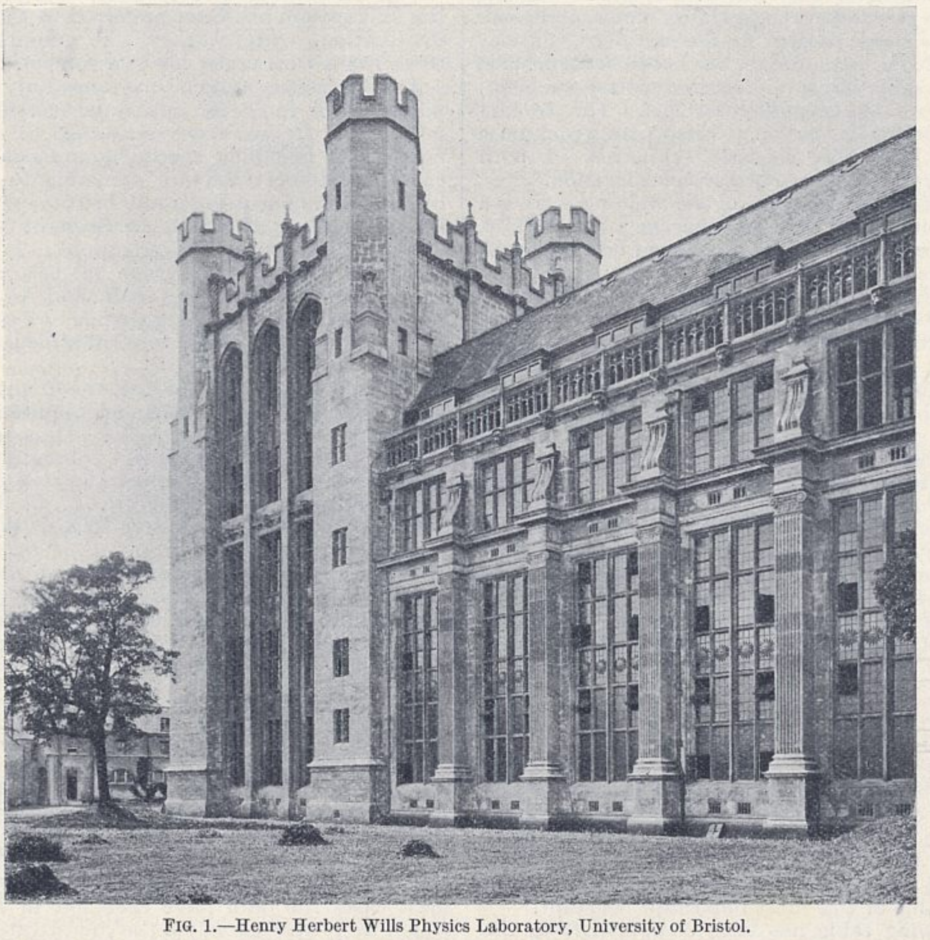

FIG. 1.—Henry Herbert Wills Physics Laboratory, University of Bristol.

Ground Floor ...	Research Rooms, Power Rooms, and Workshop.
First Floor ...	Research Rooms and Senior Teaching Laboratories.
Second Floor ...	Senior Optics and Junior Teaching Laboratories.
Third Floor ...	Library, a suite of Class Rooms, Seminars, and Private Rooms.

On each floor one or more rooms are allotted for future extension and fittings are not yet provided; the necessary supplies are, however, brought to the rooms ready for distribution later as required. In particular, on the third floor advantage is being taken of space set aside in this way to maintain a close liaison with the Department of Mathematics, which, it is anticipated, will occupy the greater part of this floor for some years to the mutual benefit of both subjects. On this floor a room 53½ by 26 feet, with a gallery, is allotted to the library, and will provide accommodation for many years for the growing needs of the two departments in this direction.

An important bequest by Mr. John Exley to the University College of Bristol in 1900 has provided the library with valuable sets of back numbers of leading scientific periodicals. The supply of these has since been maintained by annual grants which will be supplemented, owing to Council's decision to allocate to the Physics Library the income from a capital sum of about £1800 bequeathed to the University by Miss Maria Mercer.

The short arm of the "L" contains two storeys, and includes two theatres, apparatus rooms, and cloak rooms. The larger theatre, on the first floor, contains seating for 300 as a minimum, but bench seats provide for a considerably larger audience on special occasions. Its blinds are electrically controlled. The smaller theatre is beneath it, and is provided with a minimum seating of 130. The acoustic properties of both theatres have received particular consideration.

Under the roof of each arm of the building there is a large loft suitable for extensive storage or, if need be, for any special experiment requiring an uninterrupted length of space.

The junction of the two arms of the building is surmounted by a tower 64 feet square. In this there is a fourth floor containing two large rooms available for research. It is flanked by four turrets, one of which contains a vertical shaft, 4 feet by 3 feet, which goes to the bottom of the building, 90 feet below.

In the general equipment of the rooms special regard has been paid to the wishes of the donor that the furniture and fittings should be of such a high quality as would relieve the University from expenses of repairs for many years to come. The changing needs of any scientific laboratory in these days of rapid advance have, however, been constantly kept in mind, and nothing has been done to diminish the flexibility of the equipment essential to meet new conditions as required. In the provision of gas, water, and electricity in the various rooms the rival claims of the overhead system and the floorduct system have been carefully considered. It was felt that in the main teaching laboratories, where the presence of a few fixed tables distributed over the floor has no inconvenience, the floorduct system has fewer disadvantages, and for this reason it has been adopted. In the research rooms, many of which are relatively small, the supplies of gas, water, and alternating current are conveyed through the rooms in floorducts, and those of direct current of various voltages by bare wires overhead. At the same time, a horizontal duct with creeping way is provided in the roof of the main corridors. This not only serves the purpose of a vitiated air duct in the ventilation system, but also gives means for rapidly laying any temporary cable or piping as required to any room.

For the supply of compressed air and of vacuum, the unit system has been preferred to that of general distribution. Any worker who requires either of them has it thus under his own control.

The University Council has been fully alive to the necessity for funds for apparatus and for additional personnel. It has, however, aimed at avoiding the mistake of installing special equipment of a costly character before men are available to use it, and equally that of creating a number of new posts before funds are available for the provision of the apparatus necessary for their investigations. In apparatus, therefore, immediate provision has been made for the researches of the existing staff, and for the present requirements in teaching, while a small reserve fund has been set aside to form a nucleus for future needs.

In the provision of personnel the Council has found its way to meet some of the new requirements by the creation of certain new posts. Thus, as has been already announced in these columns, Dr. J. E. Lennard-Jones has been appointed to a professorship in theoretical physics and Dr. L. C. Jackson and Dr. H. W. B. Skinner to Henry Herbert Wills' research fellowships.

If, however, the laboratory is to be put to the full uses that its donor desired, further additions to the personnel and equipment will be necessary, and it is hoped that both will soon be forthcoming.

The Velocity of Light.

By M. E. J. GHEURY DE BRAY.

MOST tables of determinations of the velocity of light contain misstatements which seriously detract from their utility. Moreover, there seems to be no table available giving a fairly complete summary of the work which has been done to ascertain the exact value of this most important constant.

The following table has been compiled, from the original communications contributed by the investigators themselves, for the purpose of meeting this want. It contains every value which has been deemed by the author of the observations to be worthy of being stated as the result of a completed series of experiments, in the course of the work which ultimately led to a final value adopted as representing best the result of this work.

The history of the quest for the value of the velocity of light is conveniently divided into three periods, and the table has been accordingly divided into three sections, in a manner which the headings render self-explanatory.

The letters *TW* refer to the toothed wheel (or 'eclipse') method and *RM* to the revolving mirror method. These two methods which, although both of French origin, have become characteristic of European and American practice respectively, are classical and need no further explanation here. References to the original papers, etc., are given after the table, with brief remarks where necessary. In most cases the data have been left in the form in which they were given by the investigator or by the author of the paper, etc., himself (except that all the values of the velocity have been expressed in the same unit: kilometres per second), even when a modification suggested itself, such as when the velocity in air only was given, or when the velocity was stated with a degree of accuracy which is evidently unwarranted owing to the residual uncertainty attaching to the determination.

Not infrequently it has been impossible to ascertain the average date of a series of experiments, and in such cases, after careful consideration of the available evidence, a date has been adopted which appears to represent fairly the most probable position of the observations on the chronological scale. The values being tabulated in chronological order, it follows that mean values (to which a mean date has been assigned) are placed in the table before some of the determinations concurring in its formation. The determination of a velocity being dependent on the value of the unit of time, and the latter being determined by the time of rotation of the earth, which is suspected of variation, it is thought that the exact date may become useful in the view of further advance in knowledge, and it is desired that the table be no more found wanting in this respect than in others.

It is seen from the table that there are seven, and only seven, determinations which may be considered as trustworthy.

(In the discussion below, the abbreviated references are to publications listed at the end of this article.)

not stated. Harkness also gives as Foucault's value 298,574 ± 204, stating that this is the final result obtained from 80 observations made on Sept. 16, 18 and 21, 1862. This information is derived from the "Recueil des Travaux Scientifiques de Léon Foucault," Paris, 1878, which gives (pp. 224 and 225) the dates and numerical results of Foucault's observations on the velocity of light, made between May 22 and Sept. 21. The value still given in this "Recueil," however, is the same as that given in the *Comptes rendus*, namely, "298,000 kilometres par seconde de temps," and it is not apparent how the value given by Harkness is obtained from the data given in the "Recueil."

No.	Average date.	Investigator.	Method.	Length of base.	Base.	Velocity, km./sec.	Medium.	Remarks.
FIRST PERIOD: PIONEER EXPERIMENTS								
1	1849·5	Fizeau	TW	8,633 m.	Suresnes—Montmartre	315,300	Air	
2	1862·8	Foucault	RM	20 m.	Paris Observatory	298,000 ± 500	„	
SECOND PERIOD: CHIEFLY WITH SHORT BASES								
3	1872·0	Cornu (*a*)	TW	10,310 m.	Ecole Polytechnique—Mont Valérien	298,500 ± 300	Air	Preliminary value (rejected as doubtful).
4	1874·8	„ (*b*)	„	22,910 m.	Paris Observatory—Montlhéry	**300,400 ± 300**	Vac.	
5	„	Cornu-Helmert	„	„	„	**299,990 ± 200**	„	Cornu's results discussed by Helmert.
6	1878·0	Michelson (*a*)	RM	1986·23 ft.	U.S. Naval Academy	300,140 ± 300	„	Preliminary value (discarded).
7	1879·5	„ (*b*)	„	„	„	**299,910 ± 50**	„	Corrected value.
8	1880·9	Newcomb (*a*)	„	2550·9 m.	Fort Meyer—U.S. Naval Observatory	299,627	Air	Doubtful.
9	1881·0	Young and Forbes	TW	18,212·2 ft. and 16,835·0 ft.	Wemyss Bay—Hills behind Innellan	301,382	Vac.	Admittedly unreliable.
10	1881·7	Newcomb (*b*)	RM	3721·2 m.	Fort Meyer—Washington Monument	299,694	Air	Doubtful.
11	1881·8	„ (*c*)	„	—	—	299,810	Vac.	Mean of (*a*), (*b*), and (*d*).
12	1882·7	„ (*d*)	„	3721·2 m.	Fort Meyer—Washington Monument	**299,860 ± 30**	„	Final declared value.
13	1882·8	Michelson (*c*)	„	2049·532 ft.	Cave School of Applied Science, Cleveland	**299,853 ± 60**	„	
THIRD PERIOD: WITH VERY LONG BASES								
14	1900·4	Perrotin (*a*)	TW	11,862·2 m.	Nice Observatory—La Gaude	299,900 ± 80	Vac.	Preliminary discussion (superseded).
15	1900·4	„ (*b*)	„	„	„	300,032 ± 215	„	Final discussion (discarded).
16	1901·4	„ (*c*)	„	—	—	299,880 ± 50	„	Mean of (*a*) and (*d*) (superseded).
17	1902·4	„ (*d*)	„	45,950·7 m.	Nice Observatory—Mont Vinaigre	299,860 ± 80	„	Preliminary discussion (superseded).
18	1902·4	„ (*e*)	„	„	„	**299,901 ± 84**	„	Perrotin's final declared value.
19	1924·6	Michelson (*d*)	RM	35,385·53 m.	Mt. Wilson Observatory—Mt. St. Antonio	**299,802 ± 30**	„	Preliminary (corrected) value.
20	1926·0	„ (*e*)	„	„	„	**299,796 ± 4**	„	
21	In progress	„ (*f*)	„	About 131 km.	Mt Wilson Observatory—Mt. San Jacinto	Not yet published	„	

(1) [i, vol. 29, 1849, p. 90] and (2) [i, vol. 55, 1862, p. 501] are admittedly but rough approximations, the experiments being intended to ascertain the possibilities of the method. The unreliability of the second determination may be estimated from the fact that the deflexion from which it was deduced was only 0·7 millimetres (ii, p. 233). The first result is undoubtedly far too high, and the second is much too low. There appears to be little to choose between the two, although the second method is more likely to be the less inaccurate, being simpler in technique and of easier application. One seems justified in taking their mean.

W. Harkness (Washington Observations for 1885, Appendix III. p. 29, under the heading "Velocity of Light *in vacuo*," gives as being Fizeau's value "70,948 lieus (*sic*) of 25 to a degree = 315,324 kilometres." The former value is not the value *in vacuo*, and how the equivalent in kilometres was obtained is

(3) [iii, p. A 298, footnote] was rejected by Cornu as being affected by serious systematic errors.

(4) [iii and i, vol. 79, 1874, p. 1361]. In the *Annales* (p. A 293) the velocity is given as 300,350 in air, the additive correction to vacuum being 82; the final velocity is 300,400. In the *Comptes rendus* (p. 1363) the velocity in air is given as 300,330, and the final velocity in vacuum, obtained by multiplying by 1·0003, is 300,400. Cornu, therefore, evidently concerns himself with four significant figures only. Newcomb [vi *b*, p. 202] gives wrong years for these determinations, and the errors are copied (xi) by Michelson and Preston ("The Theory of Light," 1901 ed., p. 511).

(5) [iv, vol. 87, 1876, col. 123]. Cornu protests strongly against the treatment his results have suffered in Helmert's hands [ii, p. 227, footnote]. The probable error is estimated by Todd [v, p. 61].

(6) and (7) [vi *a*]. The first value was discarded by its author owing to its large probable error (*loc. cit.*, pp. 115-116) compared with the greater accuracy of the subsequent determination. The latter was given as 299,944±51, and rounded to 299,940±50 (*loc. cit.*, p. 141). A correction was announced later on [vi *c*, p. 244], reducing it to 299,910±50. Newcomb, when mentioning this correction, misquotes the original value, giving it as 299,942 [vi *b*, p. 119, footnote]. Todd [v, p. 61] refers to this value as given in the 'corrected slip,' but gives 299,930; no confirmation could be found.

(8) and (9) [vi *b*] are declared by Newcomb to be doubtful owing to the presence of systematic errors. "The preceding investigations and discussions seem to show that our results should depend entirely on the measures of 1882" (*loc. cit.*, p. 201). He does not trouble to reduce them to vacuum, and he does not mention their probable errors. It is only with evident reluctance, and to avoid criticism (*loc. cit.*, p. 201-2), that he includes them in a mean value (11), with (12) which is clearly the value which he favours as most reliable (*loc. cit.*, p. 202).

(9) [vii, p. 231]. Two distant reflectors, in line with the source of light at the observing station, were used so as to have two images. Other experimental features, however, were detrimental to the obtainment of good results, and this determination was severely criticised by Newcomb [vi *b*, p. 119] and by Cornu [ii, p. 229]. The result is given by the authors with an unwarranted accuracy (*loc. cit.*, p. 269), but they give no probable error.

(13) [vi *c*]. The agreement between this value and Newcomb's last determination (*d*), obtained *practically simultaneously*, is worthy of remark; it seems to show that the accuracy was greater than the probable errors seem to indicate.

(14) [i, vol. 131, 1900, p. 731], and (17) [i, vol. 135, 1902, p. 881] were evidently announced as soon as a preliminary reduction had been carried out. Their average (16) is given in the second communication (p. 883), and is generally quoted as Perrotin's final value, although these results were considerably modified in the course of the final discussion (*vide infra*, (15) and (18)).

(15) and (18) [viii]. Incredible as it may seem, this final discussion of the experiments first reported in the *Comptes rendus* (*vide supra*, (14) and (17)), makes no mention whatever of the results mentioned in these first communications. It is necessary to compare the observations themselves in order to ascertain that (*a*) and (*b*) are deduced from the same first series of observations, while (*d*) and (*e*) are deduced from the second series. The confusion is increased by the fact that (*e*) is so nearly identical with (*a*) that the latter seems to be the former rounded off, while they are actually obtained from two different series of observations over different bases. Prof. Michelson did not avoid this pitfall, and quoted Perrotin's final result as having been obtained over the shorter base instead of the longer one [x and xiii].

(19) [ix *a*, p. 256] was first given as 299,820, but a correction given later on [ix *b*, p. 2] reduced it to 299,802. It is given separately here, although, ultimately, it was 'lumped up' with others to obtain a mean, because it was evidently deemed by its author to be of sufficient accuracy to be published at once, which was not the case with any other preliminary results obtained before.

(20) [ix *b*, p. 1] is the most accurate value yet published. It is the average of several series of observations made with multi-facet mirrors, all of which are in agreement within ±1 km./sec.

(21) [ix *b*, p. 12] is announced as being in progress; the base is the longest ever used, Perrotin hitherto holding the record. It is expected to be accurate to within 1 km./sec.

The following values have also been mentioned by certain authorities, no confirmation having been obtainable.

(22) [x and xiii]. In the "table of results of the more important investigations to date," Prof. Michelson gives for his own results (presumably from the observations made in 1878–1882) the value 299,895. It is not known how it is derived. It is not the average of (*a*), (*b*), and (*c*).

(23) Abraham and Sacerdote ("Recueil de Constantes Physiques," Table 166) give 299,890 as having been obtained by Michelson in 1902. No determination appears to have been made by Michelson at about that time, but, in that year 1902 he published a paper [xi, p. 6, and xii, p. 334] in which he adopted this particular value as the most probable estimate to date, being an average of the results obtained by Cornu ("discussed by Listing," *vide infra*), Newcomb, and himself. Is this the origin of the value given in the "Recueil"?

(24). A value 299,990, alleged to have been obtained by Listing from a rediscussion of Cornu's observations is mentioned by Newcomb [vi *b*, p. 202], by Michelson, *quoting Newcomb* [xi and xii, p. 333], and by Preston (*loc. cit.*, p. 511) also *quoting Newcomb*. No trace of such a discussion by Listing could be found, but Helmert [iv, vol. 87, 1876, p. 123] obtains precisely this value 299,990 by rediscussing Cornu's results. This value, obtained by Helmert, is quoted correctly by Michelson [vi *a*, p. 144], by Todd [v, p. 61] and by Cornu [ii, p. 227]; it only masquerades as Listing's in Newcomb's Report and *in later works quoting or copying Newcomb*. Occasionally, however, Michelson refers to this value as Listing's *even when referring to another work in which it is attributed to Helmert* [xii, p. 334, l. 33]! As shown above, Newcomb made several errors of transcription, or misquoted from memory, and these were copied indiscriminately by Michelson and Preston. The evidence is fairly strong in favour of Newcomb attributing wrongly the value to Listing (who had just published a paper [iv, vol. 93, 1878, p. 369] on the solar parallax ("Einige Bemerkungen die Parallaxe der Sonne betreffend"), and that Listing's discussion of Cornu's results is non-existent. Later [x and xiii], Michelson gives Cornu's result as 299,950. This is neither Cornu's, nor Helmert's, nor "Listing's," as hitherto quoted by him and others after Newcomb; what it is could not be ascertained. It would be highly desirable that the confusion already existing should be prevented from spreading by the exertion of a little care in giving the origin of any information which cannot be traced directly to its authentic source.

The following abbreviations have been used for references which occur more than once:

i. *Comptes rendus des séances de l'Académie des Sciences, Paris.*
ii. "Rapports présentés au Congrès International de Physique," 1900, vol. 2.
iii. *Annales de l'Observatoire de Paris*, vol. 13, 1876.
iv. *Astronomische Nachrichten.*
v. *American Journal of Science*, 3d Series, vol. 19, 1880.
vi *a*. *Astronomical Papers for the American Ephemeris and Nautical Almanac*, vol. 1, Part 3.
vi *b*. *Astronomical Papers for the American Ephemeris and Nautical Almanac*, vol. 2, Part 3.
vi *c*. *Astronomical Papers for the American Ephemeris and Nautical Almanac*, vol. 2, Part 4.
vii. *Philosophical Transactions*, 1882, vol. 173, Part 1.
viii. *Annales de l'Observatoire de Nice*, vol. 11, 1908.
ix *a*. *Astrophysical Journal*, vol. 60, 1924.
ix *b*. *Astrophysical Journal*, vol. 65, 1927.
x. *Journal of the Franklin Institute*, November 1924, p. 627.
xi. *Decennial Publications of the University of Chicago*, vol. 9, 1902.
xii. *Philosophical Magazine*, 6th Series, vol. 3, 1902.
xiii. Nature, Dec. 6, 1924, p. 831.

The Tenth International Congress of Zoology.

IF, as many contend, the chief value of these international gatherings is that they bring into personal touch the scattered workers in a single field or the larger number of workers in diverse but allied fields, then the tenth Congress of Zoologists, held in Budapest on Sept. 3–10 must be pronounced a distinct success. In spite of the clash with the Congress of Geneticists at Berlin, the British Association, and the meeting of Swiss Naturalists, there were registered no fewer than 862 members, though not all actually attended; those who did came from every civilised country north of the equator, and included delegates from 183 universities, academies, museums, and learned societies. The Governments of 24 of those countries were represented by 48 official delegates, those of Great Britain and China being apparently alone in declining the invitation. So far as the British Empire was concerned, the situation was saved by the appointment of Lieut.-Col. R. B. Seymour Sewell, I.M.S., to represent the Government of India. Considering that the Congress was opened in the presence of the Minister of Education, Count Kuno Klebelsberg, and the Ministers or other official representatives of the leading Powers, and considering that on subsequent occasions selected delegates were received and entertained by the Regent and by Count Klebelsberg, it did seem to the British zoologists present that they might have been placed by their Government on a level with their distinguished colleagues from Turkey and Czechoslovakia.

This attitude of the British Government made it seem a shade ironical that the President, Prof. Géza Horváth, should have chosen the English language for just that section of his opening address which set forth the aims and results of applied zoology, the fight against the insect and mammalian enemies of our forestry and agriculture, and the relations of zoology to medicine. Speaking in French, the president sketched the work of the Permanent Committee since the Monaco Congress in 1913, and deplored the death of two of its members, Edmond Perrier and Raphael Blanchard. In German he alluded to the results of experimental genetics and cytology and the help that modern zoology received from chemistry and physics. Finally, in Italian, he dwelt on the difficulty that specialisation placed in the way of a harmonious synthesis, and emphasised the service rendered by such a congress in knitting up the several lines of research.

This specialisation, coupled with the great diversity of the 260 communications presented at the general meetings and to the nine sections, makes it difficult to give a general survey of the scientific proceedings. One may set aside the laborious week spent by the Commission on Nomenclature and the animated but futile discussion in the section on that subject, for the main decisions will shortly be communicated to NATURE. One may also, for the immediate purpose, eliminate the section of experimental cytology, which came in rather as an annex to the Congress with the declared and afterwards fulfilled intention of budding off as an independent Congress. The zoology that was left appeared as a very different kind of science from the morphological and systematic zoology of the earlier meetings. The animal and all its parts down to the individual cell are now viewed less in their structural than in their functional aspect. A chord based on this note was struck by the four speakers independently selected by the organising committee to address the opening session.

Prof. R. Hesse, of Berlin, spoke on "The Ecology of Animals: its Aims and Methods," defining ecology as that branch of biology which considers life in relation to its environment. It provides an analysis of the struggle for existence, and its goal is the recognition of the 'Epharmonie,' that is to say, those characters which bring the creature into unison with its environment. A causal explanation would not, said Dr. Hesse, be attained without a more exact knowledge of animal chemistry. Dr. Bather, of the British Museum, speaking as a palæontologist, put to the systematist the question: *Quo vadis?* In the attempt to adapt a classificatory system, constructed with a different object and on a dissimilar basis, to a representation of phylogeny, systematists had got into a tangle. Greater recognition of similarities due to environment and their expression as classificatory 'grades' might save the situation. The adaptive dynamic characters of an organism were at least as important as the inherited, static characters. Dr. Charles Gravier, of the Paris Museum of Natural History, provided a concrete example of such a study in his account of "La phase pélagique de la vie des annélides polychètes à l'époque de la maturité sexuelle," and described the pairing-dance of the Palolo worm, as observed in the sea by means of a specially constructed lamp. Finally, Prof. R. G. Harrison, of Yale University, spoke on the status and significance of tissue culture. While the isolated cell dies and therefore cannot be observed, a cell-complex cut from the organism could be kept alive for an indefinite period. Carrel, for example, had kept the heart of a chick embryo alive since 1912. The study of living tissue would lead to a knowledge of the finer structure of protoplasm and of its regeneration. Thus the growth of nerve-fibres predicted on theoretical grounds by Ramon y Cajal could be clearly seen in a tissue-culture. The practical importance of tissue-culture lay in the help it could give to the fight against cancer.

To follow this theme—the organism as a living entity, working in harmony with its environment—through all the variations and illustrations submitted to the sections is impossible here. One can but point to a few of the papers read at the general meetings. In the first of these Prof. H. Spemann, of Freiburg i. B., summarised the novel and important researches of his laboratory on what he terms "organisers" of animal development, a subject on which we hope soon to hear him in London. At the second session Dr. James Ritchie, of the Royal Scottish Museum, lectured on "The Influence of Man on the Development of Faunas." One of the effects on which he laid stress was the gradual killing off of the larger animals, with the result that the fauna of the world was assuming a more uniform character. At the same session Prof. A. Wandel, of Toulouse, directed attention to what he termed "Geographical Parthenogenesis," that is, the existence of species normally with sexual reproduction which in certain regions are strictly parthenogenetic, *e.g.* North European races of certain crustaceans, flies, butterflies, and other insects.

The third meeting listened to a most interesting lecture by Prof. K. v. Frisch, of Munich, on the senses and 'speech' of bees; to some new observations by Dr. G. Brandes, of the Dresden Zoological Garden, on the life of the orang-utan; to an account by L. R. Natvig, of Oslo, of the breeding of Reindeer in Norway, where they number 135,000, and of the methods of fighting their parasites; to the description by Prof. P. Buchner, of Greifswald, of the symbiosis obtaining between certain wood-eating insects and fungi and infusoria; and to an account of some new experiments by Prof. Gilbert Rahm, of Fribourg, which showed that life-processes could be entirely suspended in certain organisms without danger to life. At the fourth session a large audience gathered to hear Prof. Voronoff, of Paris, and his pupil, Dr. Nemes Nagy, of Budapest, but had first to listen to Prof. Novikoff, of Prag, on the value of a study of analogy, and to Dr. J. Ertl, of Budapest, on the practical results obtained with human subjects by the regeneration and transplantation of tissue, the most remarkable being those cases in which bone was transplanted. But the most applauded lecture of the Congress was that by Dr. Canti, of St. Bartholomew's, which had to be given three times. Dr. Canti's highly instructive films showing the growth of tissue and the actual division and mitosis of cells, have been shown more than once in London, but on this occasion he added films in which the results of irradiation by radium on the living tissue were clearly demonstrated. Dr. Canti had the honour of showing his film to Count Stefan Bethlen and Count Géza Teleki.

During the Congress members had the opportunity of visiting various museums and institutes, such as the National Museum, the Ornithological and Geological Institutes, the Zoological Garden, and the magnificent museum for agriculture, forestry, and land development, admirably adapted to the Hungary of pre-War days with its mines, its quarries, and its forests, but a melancholy reminder to the Hungary of to-day. The present wealth of Hungary lies in the herds and flocks of the great plain, which members had an opportunity of seeing on an excursion to the Hortsbagy Puszta, and in the vigour of its people all inspired with an intense desire to maintain the highest level of civilisation, as exemplified in the clinics of Debrecen University and the Biological Institute on Lake Balaton.

Small space is left in which to record the kindness and hospitality shown to foreign members by the Government, the Municipality of Budapest, the directors of the various institutes, and indeed all with whom the visitors were brought into contact. It pleased all to hear at the concluding meeting that the president, Prof. Horváth, had just received the Hungarian Cross for Distinguished Service of the Second Class.

The next meeting of the Congress is to be in Padua in 1930, under the presidency of Prof. Paolo Enriques. Prof. L. Joubin (Paris) has been elected president of the Permanent Committee, with Dr. M. Caullery as Secretary.

University and Educational Intelligence.

Birmingham.—A legacy of £2000, bequeathed by the late Mr. Christopher Collins, is to be added to the Biological Building fund.

On his retirement from the chair of physiology, Prof. E. W. Carlier has presented 120 volumes to the library of the Physiology Department. Prof. Carlier has also given to the department a most valuable set of 3000 microscopic preparations from his private collection, together with a number of teaching diagrams.

The Huxley Lecture is to be delivered on Thursday, Dec. 1, by Prof. A. S. Eddington, Plumian professor of astronomy and experimental philosophy in the University of Cambridge.

Among changes of the lecturing staff are the following: Resignations—Mr. H. P. Dean (mechanical engineering), Mr. L. Eastham (zoology), Mr. J. P. Rees (mining), Mr. O. C. Elvins (oil engineering). Appointments: Mr. D. A. M. Sandifer (mechanical engineering), Mr. D. L. Gunn (zoology), Dr. W. Hancock (mine rescue work), Mr. R. Glossop (metal mining).

Cambridge.—For the seventh year in succession, Trinity College announces the offer of a Research Studentship open to graduates of other universities who propose to go to Cambridge in October next as candidates for the degree of Ph.D. The value of the Studentship may be as much as £300 a year if the pecuniary circumstances of the successful candidate require so large a sum. Applications must reach the Senior Tutor not later than July 1, 1928.—The same College offers, as usual, Dominion and Colonial Exhibitions to students of Dominion and Colonial Universities who wish to go to Cambridge next October as candidates for the degree of B.A., M.Litt., M.Sc., or Ph.D. The Exhibitions are of the titular value of £40, but their actual value is such sum (if any) not exceeding the titular value as the College Council may from time to time hold to be justified by the Exhibitioner's financial circumstances. If it is made clear that the financial need of an Exhibitioner cannot possibly be met by the payment to him of the full amount of his titular emolument the Council has power, if it sees fit and if funds are available, to award him an additional payment. Candidates must apply through the principal authority of their university, and applications should reach the Senior Tutor (from whom further particulars may be obtained) by July 1, 1928.

Edinburgh.—Dr. C. H. O'Donoghue, professor of zoology in the University of Manitoba, Winnipeg, has been appointed to a senior lectureship in zoology, and Miss Irene A. F. Hilton, to a junior lectureship in zoology.

Manchester.—Dr. R. B. Wild, who has recently retired from the Leech chair of materia medica and therapeutics, has made a gift of £250 for the endowment of a prize in pharmacology.

The following appointments have been made: Assistant lecturer in metallurgy, Mr. W. Cartwright; Assistant lecturer in geology, Dr. M. B. Hodge; assistant lecturer in bacteriology, Mr. C. A. McGaughey; demonstrator in bacteriolgy, Mr. E. St. G. Gilmore; demonstrator in pathology, Mr. H. L. Sheehan; demonstrator in chemical technology, Mr. C. Chew.

Sheffield.—The University Council has made the following appointments: R. Cooper, assistant lecturer in mathematics; Dr. F. C. Chalklin, assistant lecturer in physics; and Miss Flora M. V. Brown, part-time assistant lecturer in botany.

The Committee of the Leplay House Educational Tours Association has arranged a visit to Sicily during the coming Christmas vacation to study the history of the Island, mainly through its architecture, under the leadership of Mr. Stanley Ramsey. A regional survey meeting will be held at the Collège des Ecossais, Montpellier, at the invitation of Prof. P. Geddes; the studies will be under the direction of Mr. George Morris. Full particulars can be obtained from Miss Margaret Tatton, Leplay House, 65 Belgrave Road, Westminster, S.W.1.

Mr. H. G. Beard, research assistant in the Department of Colour Chemistry at the Technical College, Huddersfield, has been appointed research chemist at Woolwich Arsenal. Mr. Beard has received the whole of his chemical education at the Huddersfield Technical College, and for the past four years has been working under the supervision of Dr. H. H. Hodgson, head of the Department, with whom he has been the joint author of numerous papers published by the Chemical Society and the Society of Chemical Industry.

Calendar of Discovery and Invention.

October 23, 1820.—The general substitution of wrought-iron rails for cast-iron rails in the early railways was brought about by the invention of John Birkinshaw, manager of the Bedlington Iron Works. Rectangular bars were first used, but on Oct. 23, 1820, he patented the T form of rail, whereby increased bearing and strength were obtained with the same weight of material. He afterwards devised the fish-bellied rail which was used in the Stockton and Darlington Railway.

October 24, 1851.—Lassell, whose discovery of Neptune's single satellite on Oct. 10, 1846, has already been referred to, prosecuted his search for other satellites for many years, but without success, until Oct. 24, 1851, when he discovered the third and fourth satellites of Uranus, and they were named Ariel and Umbriel.

October 25, 1795.—At the height of the revolutionary period in France the various academies in Paris were suppressed, and for two years men of learning had no recognised status or meeting-ground. From the ruins of the academies, however, sprang the Institut National, inaugurated on Oct. 25, 1795 (3 Brumaire, an iv.). The Institut to-day comprises five academies, of which the Academy of Sciences is one. At first it had various homes, but Napoleon housed it in the Collège Mazarin, built in 1663–70, as the Collège des Quatre Nations Réunies. Its anniversary meeting during the restoration was held on April 24, and under Napoleon III. on Aug. 19, but since 1870 it has always been held on the original day, Oct. 25. One of the functions of the Institut is that of "registering discoveries and perfecting arts and sciences."

October 25, 1847.—At a time when photography, though in its infancy, was attracting considerable attention, Niepce de Saint-Victor, an officer in the French Army, following up the discoveries of his uncle, Nicephore Niepce and Daguerre, discovered a method of photographing on glass. He gave the first account of his process in a paper communicated to the Paris Academy of Sciences on Oct. 25, 1847.

October 26, 1711.—The Board of Visitors which visits the Royal Observatory at Greenwich annually was first appointed by Queen Anne in December 1710, its origin being traceable to the unfortunate misunderstandings that prevailed between Flamsteed and some of his contemporaries. Apparently the first time the Board met the Astronomer Royal was in the rooms of the Royal Society in Crane Court on Oct. 26, 1711. The Board was empowered to demand from the Astronomer Royal a copy of his annual observations and to inspect his instruments. Flamsteed, however, had constructed some of the instruments at his own cost, and it is stated that when on this occasion he was requested to report on his instruments, he declared they were his own and he would suffer no one to concern himself with them.

October 27, 1806.—Napoleon, who had a keen appreciation of the value of scientific discoveries and inventions, often conferred rewards for such work. One instance was his recognition of the invention of the loom for figured weaving by Jacquard, to whom, by a decree dated from Berlin, Oct. 27, 1806, he gave a pension of 6000 francs.

October 29, 1852.—One method of making electrotypes was that patented by Paul Pretsch, Oct. 29, 1852, under the name of photo-galvanography. From a transparency a gelatin relief image was obtained, which, being made conductive, was coated with copper. The copper shell was then backed with type metal to produce a printing plate. E. C. S.

Societies and Academies.

LONDON.

Society of Public Analysts, Oct. 5.—**A. Chaston Chapman**: The oil of *Centrophorus granulosus*. The liver oil of the Portuguese shark 'barroso' (*Centrophorus granulosus*) contains the unsaturated hydrocarbon, spinacene, an alcohol probably identical with the batyl alcohol found in Japanese shark oils, a liquid alcohol (selachyl alcohol, $C_{21}H_{40}O_3$), cholesterol and glycerol (0·5–0·6 per cent.), together with stearic, palmitic, and oleic acid, and possibly smaller proportions of other saturated and unsaturated fatty acids.—**W. R. Schoeller** and **E. C. Deering**: The separation of titanium from tantalum and niobium. The method is based on the dissociation of the soluble tartaric complexes of the metallic acids by a mineral acid; the earth acids are precipitated, whilst the titanic salt remains in solution. The results as yet obtained are approximate.—**C. L. Hinton** and **T. Macara**: The determination of aldose sugars by means of chloramine-T, with special reference to the analysis of milk products. Each molecule of chloramine-T is equivalent to two atoms of iodine, both in the oxidation of sugar and in the final liberation of iodine on acidifying. The oxidation proceeds more slowly than that with alkaline iodide solution. The most suitable conditions for the oxidation of dextrose and lactose have been worked out, and the extent of the slight oxidation of sucrose and lævulose under standard conditions has been determined. Under the conditions specified, the action of chloramine-T on the non-sugar constituents of milk serum does not cause an error greater than 0·4 per cent. of the total lactose.

PARIS.

Academy of Sciences, Sept. 12.—**Jean Perrin**: Valency and addition compounds. A summary of various views of electronic valency with some applications to organic compounds.—**Mme. Ramart-Lucas**: The mechanism of molecular transpositions. An application of the conception of monoelectronic linkage, or semivalence, to the phenomena of intramolecular transpositions. **Pierre Viennot**: The geology of the neighbourhood of Hasparren (Basses-Pyrénées).—**G. Ollivier**: *Cutleria monoica*, gametophyte of *Aglaozonia chilosa*.—**A. Lebediantzef**: The reaction to desiccation of different types of soils in the *tchernozem* and *podzol* zones of European Russia.—**R. Wilbert**: An infectious disease of the chimpanzee, transmissible to man. This disease, which appears to be due to a spirochæte, caused the death of 32 chimpanzees out of 33. The author caught the disease but recovered. His blood contained the same spirochæte as the affected chimpanzees, and its inoculation into a chimpanzee caused its death.

Sept. 20.—**A. Lacroix**: The chemico-mineralogical characters of the tertiary intrusive and volcanic rocks of North Africa.—**G. Bigourdan**: The third general assembly of the International Geodetic and Geophysical Union. An account of the meeting held at Prague on Sept. 3–10, 1927.—**T. J. de Seze**: The degree of accuracy of common formula of resistance of materials.—**Mme. Christine Ladd-Franklin**: The visible radiation arising from stimulated nerve fibres.—**René van Aubel**: The presence of crystallised uraninite in the uraniferous deposits of Kasolo (Katanga).

Diary of Societies.

SATURDAY, OCTOBER 22.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Yorkshire District Meeting) (at the Mansion House, Doncaster), at 11 A.M.

MONDAY, OCTOBER 24.

CAMBRIDGE PHILOSOPHICAL SOCIETY (Annual General Meeting) (in Cavendish Laboratory), at 4.30.—G. C. Steward: On the Lens Interferometer.—J. A. Gaunt and W. H. McCrea: The Emission of Radiation by a Quadripole Electric Moment on the Quantum Mechanics.—E. T. S. Appleyard and Dr. H. W. B. Skinner: A Case of Double Reflexion.—Dr. F. H. Constable: On Reichinstein's Displacement Principle.—N. F. Mott: The Gas Distribution Law in a Field of Force.—G. H. Aston: The Amount of Energy Emitted in the γ-ray form of Radium E.—*To be communicated by title only*:—D. Burnett: The Relation between Refractive Index and Density.—Dr. R. A. Fisher and J. Wishart: On the Distribution of the Error of an Interpolated Value, and on the Construction of Tables.—Dr. E. Madgwick: (*a*) The Absorption and Reduction in Velocity of β-rays on their Passage through Matter; (*b*) The β-ray Spectrum of RaE.—W. H. McCrea: (*a*) The Specific Heat of Water Vapour and the Theory of the Dissociation of Water Vapour at High Temperatures; (*b*) The Specific Heat of Carbon Dioxide and the Form of the CO_2 Molecule.—R. J. Clark: (*a*) A Convenient Method of Distillation of the Alkali Metals; (*b*) A Rapid Mercury Still.

EDINBURGH ROYAL SOCIETY, at 4.30.—Presentation of Makdougall Brisbane Prize (1924–1926) to Dr. C. M. Wenyon, and his address on Insect Flagellates and Disease: A Study in Adaptation.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section, London), at 6.30.—J. Rogers: The Liquefaction of Air.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—The President and others: Discussion on What is required to Ensure the Comprehensive Distribution of Electricity?

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—Prof. F. J. Teago: Chairman's Address.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—H. Paterson: Chairman's Address.

INSTITUTION OF AUTOMOBILE ENGINEERS (Glasgow Centre) (at Royal Technical College, Glasgow), at 7.30.—Major E. G. Beaumont: The Influence of the Automobile User upon the Automobile Engineer (Presidential Address).

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—W. Rushton: Presidential Address.—F. N. Doubleday: Chronic Fuso-spirillary Infection of the Periodontal Membrane and its Treatment.

MEDICAL SOCIETY OF LONDON.—Dr. B. B. V. Lyon and others: Discussion on The Development of the Duodenal Tube and its Practical Value in Diagnosis and Treatment.

TUESDAY, OCTOBER 25.

ROYAL SOCIETY OF MEDICINE (Medicine Section), at 5.—Dr. V. Lyon: The Technique and Usefulness of Medical Biliary Drainage in Gall Tract Disease.

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre) (Informal Meeting) (at Guildhall, Derby), at 6.45.—A. E. McColl: The Lanarkshire Hydro-Electric Scheme.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—O. Bloch: Climbing Holidays and Bad Photography in the Dauphine.

WEDNESDAY, OCTOBER 26.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Prof. F. T. G. Hobday: Diseases conveyed to Man by Animals.

ROYAL SOCIETY OF MEDICINE (Comparative Medicine Section), at 5.—Prof. O. Charnock Bradley: What is Comparative Medicine?

INSTITUTION OF AUTOMOBILE ENGINEERS (Manchester Centre) (at Engineers' Club, Manchester), at 7.—Major E. G. Beaumont: The Influence of the Automobile User upon the Automobile Engineer (Presidential Address).

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (at Medical Society of London, 11 Chandos Street, W.1), at 8.30.—Dr. E. Miller: A Case of Claustrophobia.

THURSDAY, OCTOBER 27.

COKE OVEN MANAGERS ASSOCIATION (Annual General Meeting) (at Hotel Great Central), at 2.30.—G. A. Hebden: Presidential Address.

FOLK-LORE SOCIETY (jointly with Oxford University Anthropological Society) (in Geological Lecture Room, University Museum, Oxford), at 5.15.—Prof. J. L. Myres: The Historical Content of Greek Folk-memory.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.

SOCIETY OF CHEMICAL INDUSTRY AND INSTITUTE OF CHEMISTRY (Edinburgh and East of Scotland Sections) (at North British Station Hotel, Edinburgh), at 7.30.—J. Adam Watson: Chemistry, the Slave of the Lamp (Inaugural Address).

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—F. Kidd: Purpura of the Urinary Tract (Presidential Address).

MEDICO-LEGAL SOCIETY (at 11 Chandos Street, W.1), at 8.30.—Sir William Willcox: Presidential Address.

INSTITUTE OF BREWING (Midland Counties Section) (at White Horse Hotel, Birmingham).—H. Lloyd Hind: Brewer's Microscope—a Demonstration of its Selection and Use, with some Hints on Photo-micrography.

INSTITUTION OF THE RUBBER INDUSTRY (Manchester and District Section) (at Geographical Hall, Texile Institute, St. Mary's Parsonage, Manchester).—W. A. M. Keith: Transmission and Conveyor Belting.

FRIDAY, OCTOBER 28.

ASSOCIATION OF ECONOMIC BIOLOGISTS (at Imperial College (Botany Department), South Kensington), at 2.30.—Agriculture in Tropical Africa:—Dr. E. J. Butler: Planting Developments and Difficulties in Nyasaland.—W. Nowell: The Work of the Amani Institute.

ROYAL SANITARY INSTITUTE (in Town Hall, Newcastle-upon-Tyne), at 4.30.—Discussions on The Influence of Overcrowding upon Tuberculosis, with special reference to the New Housing Schemes; The New Factories Bill; and The Smoke Problem on Tyneside—How is it to be Tackled?

PHYSICAL SOCIETY (at Imperial College of Science), at 5.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration on Congenital Dislocation of the Hip and other Joints.

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (at University, Liverpool), at 6.—Dr. A. Holt: Merseyside and Chemical Industries.

INSTITUTION OF CHEMICAL ENGINEERS (at Institution of Civil Engineers), at 6.30.—Sir William Bragg: Crystallisation (Lecture).

INSTITUTION OF LOCOMOTIVE ENGINEERS (Manchester Centre) (at College of Technology, Manchester), at 7.—E. C. Poultney: Locomotive Performance and its Influence on Modern Practice.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—L. Pendred and others: Discussion on Engineering in the United States of America.

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

WEST CUMBERLAND SOCIETY OF CHEMISTS AND ENGINEERS (at Technical College, Workington), at 7.—J. E. Lambert: Use of Explosives in Mining and Quarrying.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—Technical Film Illustrating the Production of Cotton Goods.

ROYAL SOCIETY OF MEDICINE (Epidemiology Section), at 8.—Dr. E. W. Goodall: The Epidemic Constitution.

PHILOLOGICAL SOCIETY (at University College), at 8.—Rev. E. D. Priestley Evans: Place-names in -Minster.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Annual General Meeting) (at Newcastle-upon-Tyne).—M. S. Gibb: Presidential Address.

PUBLIC LECTURES.

SATURDAY, OCTOBER 22.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Mrs. H. M. Dunn: The Peoples of India.

MONDAY, OCTOBER 24.

SCHOOL OF ORIENTAL STUDIES, at 5.15.—E. R. Wood: Travel in East Africa.

TUESDAY, OCTOBER 25.

GRESHAM COLLEGE, at 6.—A. R. Hinks: A New Survey of the Nebulæ. (Succeeding Lectures on October 26, 27, 28.)

UNIVERSITY COLLEGE, at 9.—Prof. J. Garstang: Research and Discovery in Palestine, with special reference to the Hebrew University.

WEDNESDAY, OCTOBER 26.

KING'S COLLEGE, at 5.30.—A. Rannie: The Preparatory School.

INSTITUTE OF HISTORICAL RESEARCH (Malet Street, W.C.1), at 5.30.—N. B. Jopson: The Early Civilisation of the Slavonic Peoples. (Succeeding Lecture on November 2.)

LONDON SCHOOL OF ECONOMICS, at 6.—C. Wilson: Office Machinery: Underwood Invoicing and Book-keeping Machines.

THURSDAY, OCTOBER 27.

UNIVERSITY COLLEGE, at 5.30.—Viscount Cecil of Chelwood: The Co-operation of Nations (Rickman Godlee Lecture).

ROYAL SANITARY INSTITUTE, at 5.30.—W. Hales: Tropical Vegetation and some of its Uses to Man (Chadwick Public Lecture).

FRIDAY, OCTOBER 28.

UNIVERSITY COLLEGE, at 5.15.—Prof. B. Němec: Symbiosis Parasitism and Immunity in Plants.

SATURDAY, OCTOBER 29.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—M. A. Phillips: Nature at Home.

CONGRESSES, ETC.

SATURDAY, OCTOBER 22.

UNION OF EDUCATIONAL INSTITUTIONS (Annual Meeting) (at Education Offices, Birmingham), at 3.

OCTOBER 22 TO 24.

CONGRESS OF THE ITALIAN SOCIETY OF LARYNGOLOGY, RHINOLOGY, AND OTOLOGY (at Parma).

OCTOBER 23 TO 26.

MARCELIN BERTHELOT CENTENARY CELEBRATIONS (at Paris).

OCTOBER 23 TO 26.

ITALIAN CONGRESS FOR COMBATING TUBERCULOSIS (at Milan).

OCTOBER 24 TO 26.

ITALIAN CONGRESS OF INDUSTRIAL MEDICINE (at Parma, Modena, and Carpi).

OCTOBER 25 TO 28.

INTERNATIONAL CONGRESS OF HYGIENE (at Paris).

OCTOBER 29 AND 30.

ROUMANIAN CONGRESS OF OTO-RHINO-LARYNGOLOGY (at Bucarest).