NATURE

SATURDAY, MARCH 16, 1929.

CONTENTS.

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.

No. 3098, Vol. 123]

The Natural History Museum at South Kensington.

ZOOLOGISTS, by an overwhelming majority in open meeting, have expressed their sense of dissatisfaction at the present system of control of the British Museum of Natural History, which is mainly devoted to their science, and is regarded by them as their place of reference for all questions relating to the different species of animals. This Museum is a branch of the British Museum, the home of which is at Bloomsbury, its chief function being the care of art and ethnological collections and the maintenance of a Library. It is governed by a Board of fifty-one Trustees, of whom the Archbishop of Canterbury, the Lord Chancellor, and the Speaker of the House of Commons are Principal Trustees.[1] There is also a trustee appointed by the Sovereign, and twenty-four 'official' trustees. Among these are the president of the Royal Society and the president of the Royal College of Physicians—the sole representatives of the natural sciences. There are in addition nine representatives of families whose magnificent gifts have enriched the State. Several distinguished men of science are included, however, among fifteen trustees 'elected' by their colleagues on the nomination of the principal trustees.

The trustees act through a standing committee of twenty members, which meets ten times a year at Bloomsbury and eight times at South Kensington. This committee consists largely of the elected trustees "appointed because they are known to be interested in the work as well as competent," and it guides the administrative business of each museum in an efficient manner. The direction, however, of a museum of natural history is very different from that of a picture gallery or an art museum: the problems which come before the governing body for solution require, therefore, a different kind of knowledge, and unless governed on different lines, neither institution can achieve full success or have full scope for development. Indeed, it is obvious that the policy of the Natural History Museum is controlled by its director, and his duty—to maintain its collections—necessitates the choice of a systematic specialist, a side increasingly separating year by year from university and industrial research. To assist the director effectively, he requires a representative body of naturalists and industrialists as trustees; and such

[1] A full account of the method of governing the Museum is given in the very interesting Memorandum presented by Sir Frederic Kenyon to the Royal Commission on National Museums and Galleries and printed in the volume of evidence, p. 51.

a body would not have the requisite knowledge or interest for the care of the priceless collections at Bloomsbury.

Under these conditions it is necessary to consider the advisability of severing the bonds which bind the two sides of the British Museum together. The director of the British Museum is the head accounting officer for both, and hence alone has access to the Treasury. While preserving their connexion and governance, a separate accounting branch for the Natural History Museum was offered, but its then director refused, not wishing to be troubled while he had a building free from congestion, and a science at that time scarcely connected, even remotely, with public health and industry. This change might be made now, but, while certainly beneficial, does not go to the root of the matter. Rightly or wrongly, naturalists have shown their dissatisfaction with the present arrangements by repeated memorials to the Government of the day during the last sixty years. In 1866, while the collections were still housed at Bloomsbury, they presented a memorial to the Chancellor of the Exchequer in which they state their view in clear terms: "We are of opinion that it is of fundamental importance to the progress of the Natural Sciences in this country that the administration of the National Natural History Collections should be separated from that of the Library and Art Collections, and placed under one officer who should be immediately responsible to one of the Queen's Ministers." To this memorial twenty-five signatures only were appended, but they were those of the foremost naturalists in the country, Charles Darwin, Huxley, Hooker, Lord Lilford, Wallace, and others—men of international renown.

The Royal Commission on Scientific Instruction and the Advancement of Science took evidence on this matter with great care. The commissioners summarise the evidence they received by expressing their opinion in 1874, "that the objections to the present System of Government of the British Museum by a Board of Trustees, as at present constituted, so far as relates to the Natural History Collections, are well founded; and we have been unable to discover that the system is attended by any compensating advantages." They recommended that the director "should be appointed by the Crown . . . and under the control of a Minister of State, to whom he should be immediately responsible." They also suggested an expert Board of Visitors, the members of which should be appointed for a limited period, but be re-eligible, and who should make annual reports to the Minister, to be laid before Parliament.

Nothing was done, and the Council of the British Association in 1879, a bill having been passed in the previous session to authorise the trustees to transfer the Natural History Collections into the new building at South Kensington, without any reference to a separation in governance, memorialised the First Lord of the Treasury to this end, but without effect. The superintendent of the Natural History Museum was made director in 1885 with a comparative independence, which was revoked in 1898. In 1908 a deputation, representative of zoology, botany, and geology, was received by the Prime Minister (Mr. Asquith) and asked for a full official inquiry into the organisation of the Natural History Museum. This was refused, as the trustees are a statutory body with whom the Government is powerless to interfere, an extraordinary position for a Prime Minister. He sympathised with the view that the director should have a free hand in the management of his department, and promised to convey to his fellow trustees of the British Museum all that the deputation had suggested. No alteration, however, was made.

In the meantime zoology has advanced by leaps and bounds. It is no longer a subject of purely philosophical interest. That the facts of heredity in man and animals are vital to the due governance of any State is now clear. Fisheries to a large extent depend on the study of the development of fish and of their habits at different ages in relation to the physical and chemical conditions of the water in which they live. The study of wools, silks, and hides has materially affected important industries, and all breeding is carried on for specific ends, for food, for transport, or for raw products of manufacture. The microscopical study of unicellular animals has resulted in the amelioration of the lot of mankind in respect to malaria and many other diseases, and scientific measures are in force over a large part of Africa against sleeping sickness. The Imperial Bureau of Entomology has its centre in the Natural History Museum, much of its work based on the national collections, and especially cares for crops so far as insect and other attacks are concerned. Many molluscs are valuable as food, some for their shells, and the study of corals and marine plants is necessary in respect to navigation in the tropics. Indeed, there is to-day the recognition that the study of animals is vital to man's civilisation and progress, and all our colonies employ specialists to apply the laws of their science.

These laws are largely the aims in research at the universities, the understanding of the structure in relation to the manifold activities of the living matter upon which all organisms depend. The two sides of this and of all sciences are inextricably bound, for progress in understanding must always precede scientific application.

Representatives of all these aspects of animal life look to the Natural History Museum to catalogue and to store specimens for reference, and there is not a single group which is free from their activities. All animals have fundamental points of relationship, and it is commonly essential for an investigator to have to refer to a dozen or more forms in as many groups. They are vitally interested in the Natural History Museum, and they cannot agree, to-day, with Mr. Asquith, in 1908, that the trustees are "equally cognisant of natural history and archæology" in the sense of knowledge of the needs of scientific and applied zoology. They do not see how due representation of their present and future aims can be given without such a large increase in the body of trustees as to amount to a complete reconstruction. They consider that the Museum in future will have to extend its activities into the field and to collect the animals it requires, if it is to maintain its utility. A director brought up within its walls for twenty or thirty years will even, in the next decade, be necessarily out of touch with his fellow zoologists outside, yet it would be deplored if his post, which should be the ambition of every member of the staff, should on a vacancy be filled necessarily from outside.

With these views scientific men generally find themselves in cordial agreement. They ask for no exceptional treatment, only for their affairs to be managed by a board of governors, which may be divided into those who have knowledge and judgment in respect to their activities, and those who are interested in the successful prosecution of such for national ends. We feel that there is no reason to perpetuate any form of governance by trustees or otherwise, if a better method can be devised. Evolution is equally a law in organic science and in national affairs; and for the welfare of both, progress is essential. No State is wise to refuse inquiry if any class of its subjects clearly demands it, and there seems to be practical unanimity here. Fortunately, a suitable body for such investigation is in existence—the Royal Commission on National Museums and Galleries; and the evidence submitted is so cogent and suggestive that we are confident it will lead to constructive conclusions.

British Floods and Droughts.

British Floods and Droughts. By Dr. C. E. P. Brooks and Dr. J. Glasspoole. With an Introductory Note by Dr. Hugh Robert Mill. Pp. 100 +2 plates. (London: Ernest Benn, Ltd., 1928.) 10*s.* 6*d.* net.

THIS book will attract many readers by its title, and they are not likely to be disappointed in its contents, which embrace entertaining accounts of notable floods and droughts in the British Isles back to quite early times, together with a wealth of statistical data about rainfall fluctuations compressed into a comparatively small volume. In the rain-rich climate of the British Islands, flooding is perhaps a more familiar condition than one of drought, but, as the authors truly observe, the vicissitudes neither of one nor the other are anything but mild compared with what occur in many other countries. In fact, it would be true to say that the climate of these islands is well-balanced or even-tempered, not in spite of its variability but because of it, inasmuch as excesses in any direction rarely last long enough to pass from the stage of an entertaining diversion from the monotony of normal conditions into that of serious distress and danger. In other words, the weather here provides plenty of stimulus, physical and mental, at a smaller cost in life and suffering than is the case in some parts of the world.

After an introduction on the general subject of rainfall in the British Isles, Dr. Brooks and Dr. Glasspoole, experts in this subject, arrange the fourteen chapters of their book into three parts: I. Great Rains and Floods; II. Droughts; III. Variations of Rainfall. British floods are of several types. The most familiar floods are the widespread, slowly rising river-valley floods that may follow excessive rainfall at any season of the year, but most frequently in winter when melting snow may also be a factor. The great Thames floods of November 1894, the Severn floods of May 1886, the Tees floods of September 1927, the Norwich floods of August 1912, the destructive thaw floods in the Scottish Highlands of January 1892, the historic Morayshire inundations of August 1829, are all outstanding examples of this class of flood. The Norwich flood forms the subject of the frontispiece. It was caused by a cyclonic downpour yielding 8 inches of rain in 24 hours on the top of previous heavy rains.

Floods of the 'cloud-burst' type in association with summer thunderstorms are more localised but also more dangerous, for they rise suddenly

when 5 or more inches of rain come down in a few hours of storm, and the water seems to fall in a solid sheet. The Louth disaster of Whitsuntide 1920, when 22 persons were drowned, as a great thunderstorm burst over the Lincolnshire Wolds, was of this character. A similarly impressive storm took place at Driffield at the foot of the Yorkshire Wolds on July 3, 1892. Cloudbursts, however, have been peculiarly prolific in the mountainous districts of South Wales and along the bold Pennine–Cheviot backbone of northern England. On July 2, 1893, one such storm bursting over the wilds of the Cheviots ploughed up many acres of black peat on the desolate fellside of Bloodybush Edge, Northumberland.

Of tidal floods, the most serious of modern times was that of Jan. 6, 1928, on the east coast and up the Thames estuary, taking toll of fourteen lives in London. It was due to the combined factors of a spring tide, a severe gale in the North Sea, and an upper Thames charged with snow-water. In the Middle Ages when, according to Prof. Otto Pettersson, both the tide-raising forces and the storminess were at a maximum, tidal floods caused enormous devastation and loss of life on the North Sea coast both of England and Holland. We have also floods due to the failure of dams, as when 245 lives were lost by the bursting of the Bradfield Reservoir, near Sheffield, on Mar. 11, 1866.

British droughts appear to have been severe in the eighteenth century, but in modern times the worst droughts of a protracted character were probably those of 1887 in the north-west of England and 1921 in the south-east, when there was a great dearth of water and milk in many districts. The great spring drought of 1893, however, was more acute while it lasted, many places in Kent and Sussex, as well as London, experiencing two or more absolutely rainless months. Dry weather, while it lasts, can be very intense in the wet western parts of the British Isles, but it has more definite bounding dates without the periods of faltering rainfall before and after, which are sometimes so pernicious in the dry eastern parts.

The book contains useful information about the extreme variations of rainfall since the establishment of reliable rainfall records on an extensive scale, that is, from about 1870. Thus the highest annual rainfall total on record is 247 inches at the Stye Head, Cumberland, in 1923, and the lowest, 10 inches, at Margate, in 1921 ; but the latter year was only the driest in the south-east of England, whilst the former was nowhere near the wettest over the British Isles generally. The highest two daily totals, close to 9½ inches, both, curiously enough, belong to Somerset, the one case at Bruton on June 28, 1917, and the other near Bridgwater on Aug. 18, 1924. The longest duration of *absolutely* continuous rainfall, namely, 58½ hours, is on record for Camden Square, London, between 1 P.M. on June 11 and 11.30 P.M. on June 13, 1903. As the duration of continuous rain is an interesting and important aspect of climate, it is to be regretted that the authors do not warn their readers that the number of self-recording rain-gauges is relatively small, and that it is unlikely that London really holds such a record. In the hill districts of Britain where the rainfall is excessive, bad weather is often of a most unrelenting character. Rain that will cease for an interval in the plains has there a way of simply altering its character, of changing its tune, so to speak, from heavy driving sheets to a teasing, drenching drizzle, and back again, and it is highly probable that in the high hills sixty or more hours of continuous rain is not very uncommon.

The methods adopted by the authors for estimating the rainfall of the country to a good approximation in earlier periods when rain-gauges were few are ingenious, whilst their treatment in the last chapter of the study of weather periodicities and recurrencies is cautious but suggestive. The periodic component in the make-up of the weather is, as Capt. Brunt has shown, small, and of very little use in forecasting ; but the curves produced by Drs. Brooks and Glasspoole permit of a hope, though not a forecast, that the tide is about to turn, and that the wet spell of years that has marked the first quarter of the century, and especially the last six years, will soon be broken, with a tendency to finer summers. May we say, however, that we think the authors have been a little too insistent in their emphasis on the dismal side of rainy summers like 1924 and 1927 ? Excessive summer rains are admittedly inconvenient and may worry the farmer, but they bestow lavish beauty upon earth and sky and play no small part in the making of "England's green and pleasant land." The form and lighting of the clouds and the wild and fantastic sunsets in a rainy summer are incomparable ! Moreover, there are always plenty of delightful intervals and ideal days in the worst of summers if people would only choose to see them, and in this connexion the authors rightly point out that the wet August Bank Holiday of 1927 gave the whole summer a reputation which it did not deserve.

L. C. W. BONACINA.

Scottish Ornithology.

The Geographical Distribution and Status of Birds in Scotland. By Evelyn V. Baxter and Leonore Jeffery Rintoul. Pp. vii + 425. (Edinburgh and London: Oliver and Boyd, 1928.) 15*s*. net.

THE feathered population of the British Isles has been subjected of late years to scrutiny so intense as to cause misgiving, and in some cases indignation, among such lovers of birds as are not specialists.

The conditions necessary for the satisfaction of the scrupulous framers of ornithological statistics imply the slaughter, euphemistically termed the 'collection' or 'securing,' of very many harmless birds. In the *Zoologist* for January 1913, Dr. C. J. Patten, in discussing the reported occurrence of four Redbreasts, *Erithacus rubecula*, at the Tuskar Lighthouse, remarked: "The birds were not captured, and so these occurrences cannot carry the same weight that they would had the specimens been secured and forwarded for corroboration."

In their volume on "The Geographical Distribution and Status of Birds in Scotland," Miss Baxter and Miss Rintoul are at pains to distinguish between the British and Continental forms of several species. In regard to the Redbreast, for example, while they record the British form as resident in every part of Scotland except Shetland and St. Kilda, the Continental variety is reported from only fourteen localities. Now, whereas the difference between the two subspecies cannot be detected until specimens are in hand, hundreds of Redbreasts must have been 'collected' to establish a fact not of first-rate importance. We do not accuse the authors of a direct share in such slaughter, but their statistics are founded on the result of industry in that line on the part of others; and they inform the reader in the preface that "a great deal of work remains to be done before we have a comprehensive knowledge of the status in Scotland of even our commonest birds."

We note with satisfaction that the authors observe timely reticence by withholding information about certain scarce birds, remarking that "in some instances in the interests of birds themselves it has been necessary to suppress the localities where they breed; for example, the Greenshank in Southern Scotland." It would have been well to observe the same precaution in respect to some other species—the Chough, for example, which formerly used to breed in many parts of Scotland but is now resident in two places only, where it is in imminent danger of extermination owing to the hostility of jackdaws and the baneful industry of collectors.

The authors consider it expedient to comply with modern practice in duplicating specific names, and I suppose we must not attribute it to a deficient sense of humour which sanctions the diminutive wren to be heralded as *Troglodytes troglodytes troglodytes*; but surely injustice is done to the great pioneer of classification by adding (L) to these cumbrous titles. Linnæus was content to denote the wren as *Motacilla troglodytes*, and assuredly he would have disclaimed having laden the Grey Plover with such cacophonous polysyllables as *Squatarola squatarola squatarola*! Clumsy nomenclature such as this causes the enemy to blaspheme and friends to complain. In such cases as it may be desired to duplicate the specific name, this might be conveniently indicated by adding a numeral (2).

The Buffet-headed Duck, *Clangula albeola*, is not mentioned in the volume under review, although Yarrell records a solitary instance of its occurrence in Orkney in 1841, and states that the bird was to be preserved in the Natural History Museum at Margate.

The foregoing frank criticism must not be interpreted as unfavourable to what is a thorough piece of work, which must have cost the authors no slight labour to compile and will prove very useful for reference. HERBERT MAXWELL.

Crystal Physics.

(1) *Lehrbuch der Kristallphysik (mit Ausschluss der Kristalloptik)*. Von Prof. Dr. Woldemar Voigt. Nachdruck der ersten Auflage ergänzt durch eine spätere Arbeit des Verfassers und mit einem Geleitwort von Prof. M. v. Laue. (Sammlung von Lehrbüchern auf dem Gebiete der mathematischen Wissenschaften mit Einschluss ihrer Anwendungen, Band 34.) Pp. xxvi + 978. (Leipzig und Berlin: B. G. Teubner, 1928.) 41 gold marks.

(2) *The Physics of Crystals*. By Dr. Abram F. Joffé. Edited by Prof. Leonard B. Loeb. Pp. xi + 198. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1928.) 15*s*. net.

(3) *Bibliography of Crystal Structure*. By Jared Kirtland Morse. Pp. xix × 164. (Chicago: University of Chicago Press; London: Cambridge University Press, 1928.) 15*s*. net.

IT cannot be too strongly emphasised that crystal physics is no longer a highly specialised branch of physics, dealing with solid matter in what was

formerly thought to be a comparatively rare state. The new crystallography has shown, by the study of the interaction of X-rays and solids, that the normal stable state of most, and probably all, solid matter is essentially crystalline; that is, there is always a tendency for a group of ions, atoms, or molecules of the same kind to arrange themselves in the solid state in an orderly way. Even such substances as stretched rubber and gelatin, and the fibres of our bodies, have given evidence of an orderliness in the arrangement of the units from which they are built. This new outlook makes specially welcome the present volumes on crystal physics.

(1) Since Voigt's "Lehrbuch der Krystallphysik" has been reprinted by the photomechanical process, it is identical, save for a few additions, with the original edition of 1910. Its outlook is therefore essentially that of classical crystallography. The whole field is covered from geometrical and mechanical to electrical properties of crystals. There is, unfortunately, no index. Naturally, for particular subjects one would look to other sources, such as Love's "Elasticity" or the Geiger and Scheel "Handbuch der Physik," but there is no other book covering the work up to 1910 so well. The treatment is mathematical wherever possible, and there is for the research worker too little detail of experimental methods. Nevertheless, this reprint is of value, and since the original is so comprehensive and the outlook so classical, it would be much simpler to write an entirely new book than to revise Voigt's monumental work. In its present form it gives the research worker a good idea of the many types of research possible in crystal physics.

(2) In Joffé's book we have an attractive account of twenty-five years' research upon certain problems relating to the elastic and electrical properties. An invitation to give a course of lectures in the University of California was used as an opportunity to organise into a consistent whole the results of many researches carried out by Joffé and his collaborators. The outlook is fundamentally modern, as can be seen by the opening of the first lecture, where a crystal is defined as a regular arrangement of small units (atoms, ions, or molecules). The electrical theory of crystal lattices is developed, and it is pointed out that no more than the 10^{-15} part of the space is occupied by the electrons and nucleii, the crystal being regarded as an empty space with small charged particles distributed at enormous distances apart.

In the first six lectures it is shown how the general predictions of the electrical theory were checked both qualitatively and quantitatively by a diverse series of experimental studies upon the elastic properties of crystals. The fascinating account of these experiments admirably conveys the impression of research workers absorbed in their work and ready to adopt any tactics to solve their particular problems. For example, no sooner is the X-ray Laue method well established than it is applied to the study of the elastic limit (Lecture IV.) with results not easily attainable by other methods.

The remaining eleven lectures deal with certain electrical properties of crystals in a way that gives the reader the thrill of research well and truly carried out. For other research workers there is perhaps too little of that important section of research laboratory, the library. In the chapters on the mechanical properties of crystals, one looks in vain for such names as Carpenter, Elam, and Taylor. The book must not, therefore, be used as if it were a summary of work so far done in the subjects. Its title is misleading, since in the preface it is clearly stated that only a limited portion of the field of the elastic and electrical properties of solids is covered. Some of the work discussed would, however, otherwise be available only in Russian. The English is sometimes a little difficult; for example, a statement in the preface that "all atoms of a crystal are in the same relative position" is untrue, as it stands. The most notable feature of the book is that such interesting and valuable work is presented so as to make the reader feel that he is himself discovering the facts with the research workers in the laboratory.

(3) We turn now to the third volume, which is published as the first *Bulletin* of the Crystal Structure Laboratory of the University of Chicago. The greater part of this is a bibliography of publications on crystal structure and related topics published between 1912 and 1927. The classification is into sixteen groups according to the year of publication, and the papers of each year are arranged alphabetically under authors. The title of each paper is given in English. Joint papers are placed under the name of the author whose name appears first on the paper, but there are no cross references. A set of reprints of one well-known worker was used to test the completeness of the bibliography. Four out of eight papers had been omitted, one from the *Phil. Mag.*, one from the *J. Chem. Soc.*, and two from the *Min. Mag.*, all well-known journals. In spite of this the bibliography seems to be very comprehensive, and its use will be very considerably increased when an index is provided in one of the later *Bulletins*.

In order to make known ("better known" in the original) the work of the Crystal Structure Laboratory, the bibliography is preceded by an introduction which is largely made up of terminological inexactitudes and is often in questionable taste. In one place a programme of investigation of the laboratory is given, consisting of a list of apparently every known type of work in X-ray crystallography classified into four sections. We are then actually told that "already fundamental contributions have been published in the majority of these sections." We need be in no doubt as to what these fundamental contributions are. "The most striking and important contributions of the Crystal Structure Laboratory to date have been in the solution of the structure of these two substances —methane and benzene." The papers giving the solutions are reprinted in the *Bulletin*, and appear to be nothing more or less than interesting speculations. They certainly do not justify the statement that "the structure of the benzene ring has been solved." The crystal structure proposed for ethane is not even hexagonal, and the paper suggests that the author is unaware of this disagreement with crystallographic evidence. Moreover, the normal procedure of the X-ray crystallographer is to reject a proposed structure if observed and calculated intensities of X-ray reflections disagree. Mr. Morse prefers to suggest that such disagreements between his own proposed structures and the experimental observations of others "may lead to a fundamental revision of our present simple notions concerning the scattering of atoms."

Apparently the only structure work that has been completed in the Laboratory is a determination of the space group of certain sulphates. For this purpose the Laue method alone was used. Whilst it is true that really able workers, such as Wyckoff, have used this method exclusively with great success, the tendency nowadays is not to rely solely upon one method. There appears to be little point in equipping this Laboratory so fully if the full advantages available are neglected.

The thought of possible injury to the feelings of Mr. Morse and the University of Chicago caused the reviewer to hesitate long before referring thus to the first publication of a newly established Laboratory, but some expression should surely be given of the sense of injury produced in the, comparatively speaking, poverty-stricken research workers in pure science in Great Britain when they see part of the world's research funds used in this way while so many problems lack the support needed for their investigation.

W. H. GEORGE.

Our Bookshelf.

Sheep Production. By Levi Jackson Horlacher. (McGraw-Hill Publications in the Agricultural and Botanical Sciences.) Pp. x+418. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1927.) 20*s.* net.

THIS book is partly the result of the impetus which has been given to the sheep industry in the U.S.A. during the last five years, and its consequent repercussion on the enrolments in courses on sheep husbandry in the American agricultural colleges. It is written primarily for the sheep producer of America. In consequence, its value to the British agriculturist is not excessive. To the student of animal ecology, who may desire a rapid survey of the growth and distribution of the sheep industry in the United States, it will be useful. The treatment, while not exactly exhaustive, cannot be described as superficial. A large amount of information, hitherto only available in *Bulletins* and *Circulars* of the U.S. Department of Agriculture and in various publications from State experimental stations, has been gathered together under one cover, and made readily available by a satisfactory index.

The book is divided into four parts. An introductory portion describes the history and development of sheep production, anatomy (briefly), judging, and feeding and digestion. General accounts of each are given, which, while adequate for the needs of the agricultural student, are of little use to the advanced worker. Part 2 consists of an account of the general principles of sheep breeding, with a description of each of the breeds of American importance. Part 3 deals with the establishment and management of a flock, having regard to the suitability of certain breeds and crosses for different localities and markets available. Methods of production for mutton and wool are well and clearly stated, and this part will probably be of greatest interest to British readers. The concluding part consists of a short glossary of terms connected with sheep and wool.

The book is, on the whole, well written, opinions are clearly stated, and logical reasons are offered for most of the conclusions drawn. The illustrations, of which there are 137, are either diagrammatic or reproductions from photographs, and are mostly very good, although the American tendency to include landscape views, which either have but little bearing on the subject or mask its outlines, is evident in a number of them. The publishers have done their part of the work in their usual satisfactory manner.

La chimie d'hier et d'aujourd'hui. Par Dr. A. Kirrmann. Pp. vii + 148. (Paris: Gauthier-Villars et Cie, 1928.) 15 francs.

THIS is an interesting little book, which may be read with profit by the layman and with pleasure by the enterprising student of chemistry; so far as we are aware, it has no exact counterpart in English. It is very successful in affording within a modest

compass a very readable general account of the nature and scope of modern chemistry, of the problems which the chemist has to face, and of his methods of attacking them in the laboratory. In tracing the historical development of chemistry, the author rightly insists that "rien ne pouvait ensuite mieux préciser le caractère de cette science que l'étude de son développement historique, de l'évolution des idées directrices et de la description de l'enrichissement progressif des connaissances humaines."

The work contains a short list of technical terms and thumb-nail biographies of some fifty celebrated chemists of the eighteenth century and later. The *cognoscenti* will appreciate the statements that among the qualifications of the successful research worker are "une imagination active," "une grande habileté manuelle," "une patience sans bornes," and "une érudition suffisante pour éviter de s'attaquer à des questions déjà résolues." We commend also to the attention of all optimistic candidates for the Ph.D. after nine terms' research the closing sentence of this chapter: "Le travail de laboratoire peut être terriblement ingrat et le moindre résultat exige une dépense sans compter et de temps et d'efforts." J. R.

Die Physik, 1914–1926: Siebzehn ausgewählte Kapitel. Von Prof. O. D. Chwolson. Aus dem Russichen übersetzt von Georg Kluge. Pp. ix + 696. (Braunschweig: Friedr. Vieweg und Sohn, A.-G., 1927.) 35 gold marks.

THIS volume is similar in many respects to Prof. Andrade's "Structure of the Atom," both in its scope and in the obvious enthusiasm with which it has been written. It partakes, however, rather more of the nature of a collection of independent essays, whilst it has a natural bias towards the German and Russian points of view. Written as an appendix to Prof. Chwolson's general text-book of physics, it had its origin in an attempt to summarise for Russian students the work done elsewhere between 1914 and 1922, when the country was isolated; how well it has succeeded may be judged from the fact that it has been translated into French as well as into German.

A commendable balance between theory and experiment has been maintained throughout, and there is a satisfactory selection of good figures and of tables of numerical data, whilst each section includes a bibliography. Physics has advanced considerably since 1926, but even where much new ground has been broken, Prof. Chwolson's accounts of the older researches are stimulating, and should be particularly valuable for physics students starting for the first time on experimental research.

Cambridge Observations. Vol. 24, Part 2: *Catalogue of Zodiacal Stars for the Equinox 1900·0 from Observations made in the Years 1900–1918.* Pp. vi + 58. (Cambridge: At the University Press, 1928.) 5*s.* net.

SIR DAVID GILL indicated the importance of accurately surveying all the brighter stars in the zodiacal region, to render them available as comparison stars for the moon and planets. Of late years the value of such observations has been further emphasised, since Prof. Brown, Dr. Spencer Jones, and Dr. Innes have all shown that very accurate determinations of the moon's errors can be obtained from observations of the occultations of stars, provided that good positions of the latter are available. The Cambridge University Observatory has been engaged since 1900, but with many interruptions, in observing the stars in Sir David Gill's list, and a catalogue containing positions for 1900·0 of 2588 stars out of the 2798 in Gill's list has been published. The average number of observations of each star is about five; very few have less than three observations in each co-ordinate. The observations are not fundamental, but depend on Newcomb's positions of the standard stars. Magnitude equation has been applied; it is nearly the same for all the observers, being in the mean −0·01 sec. for magnitude 4·5, and increasing fairly uniformly to −0·08 sec. for magnitude 9·0.

The Right Ascensions were observed by eye and ear up till 1914, and by chronograph in 1917–1918. Proper motions have not been applied.

A. C. D. C.

A Text-Book of Inorganic Chemistry. Edited by Dr. J. Newton Friend. (Griffin's Scientific Text-Books.) Vol. 6, Part 1: *Nitrogen.* By Dr. Edmund B. R. Prideaux and Herbert Lambourne. Pp. xxviii + 242. (London: Charles Griffin and Co., Ltd., 1928.) 18*s.* net.

A VOLUME on nitrogen provides an exceptional opportunity for a chemist who is alert to the interesting features of his science, since such a volume necessarily includes the foremost technical problem of the day, that of the 'fixation' of nitrogen, as well as some of the most hotly debated questions of molecular structure. The latter category covers the problems of variable valency, mixed double bonds and co-ordination, and even then leaves the stereochemistry of the element to be dealt with in the light of modern knowledge. No higher compliment need be paid to the authors than that they have made adequate use of their opportunities, and have produced a volume which does justice to the fascinating element with which it deals.

The Ordinall of Alchimy. By Thomas Norton of Bristoll. Being a Facsimile Reproduction from Theatrum Chemicum Britannicum, with Annotations by Elias Ashmole. With Introduction by Dr. E. J. Holmyard. Pp. viii + 125. (London: Edward Arnold and Co., 1928.) 10*s.* 6*d.* net.

DR. HOLMYARD has earned the gratitude of all interested in the history of chemistry by his preparation of this book. Norton's poem, although it has no particular value from the point of view of the development of chemistry, gives, if it is authentic, an interesting picture of early alchemy in Great Britain, and since the original is difficult to obtain, this reprint (in facsimile) will appeal to many readers.

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.*]

Eddington's Hypothesis and the Electronic Charge.

PROF. SIEGBAHN has directed my attention to the paper in the *Proceedings of the Royal Society* for January 1929, p. 358, in which Prof. Eddington arrives at the relation between the electronic charge e and the ratio $hc/2\pi$,

$$\frac{hc}{2\pi e^2} = 136.$$

On page 174 of NATURE for Feb. 2, 1929, some editorial remarks are made concerning this relation, and it is stated that "*all* existing experimental evidence . . . are in favour of a value very near to 137." Inasmuch as I have carried out an investigation in this field, the results of which were mentioned in Eddington's paper, but which were published only in *Upsala Universitets Årsskrift*, 1928 (Diss., May 1928), I may be permitted to make a few remarks upon the subject.

The commonly accepted value of e ($4{\cdot}774 \times 10^{-10}$ E.S.U. $\pm 0{\cdot}1$ %) was determined by Millikan in 1916. There are, so far as I know, no redeterminations of e which claim the same degree of accuracy. In the investigation carried out by myself the absolute wavelength of the aluminum $K\alpha$-line was determined by means of a ruled, plane reflection grating. From this and the known crystal value of the same spectral line, I computed a new value of e, namely, $4{\cdot}793 \times 10^{-10}$ E.S.U. $\pm 0{\cdot}3$ %. In a recent paper (*Phys. Rev.*, Dec. 1928), A. P. R. Wadlund, using the same general method (Compton, 1925), gives a value of e ($4{\cdot}774 \times 10^{-10}$ E.S.U. $\pm 0{\cdot}15$ %) which is exactly the same as that found by Millikan.

In order to determine the reliability of these three values, each being the mean of comparatively few determinations, it is of importance to analyse in each case the distribution of the individually determined values around their mean. For each of his twenty-five investigated drops Millikan obtained a value of $e^{2/3}$, and from the distribution of these single values he has computed the 'probable error' to be $\pm 0{\cdot}025$ %. From the published $e^{2/3}$-values I have calculated each single e-value. From their distribution the 'probable error' was found by the usual methods to be $\pm 0{\cdot}04$ %, which agrees with that found by Millikan related to $e^{2/3}$, namely, $3/2 \times 0{\cdot}025 = 0{\cdot}038$. In the diagram (Fig. 1) I have plotted the number (Z) of values falling in the intervals 0-0·1 %, 0·1-0·2 %, etc., from the mean. The upper curve represents the error distribution for Millikan's determinations. The lower figure is the error distribution curve obtained in the same manner from my own single values (29). My mean value is 4·793 and is 0·4 % greater than Millikan's. At the bottom of the diagram I have plotted Wadlund's mean value with its published error limits and also its probable error as given in his paper. In his paper only one single value of the nine obtained is published, and if this is indicative of his series of measurements, his error distribution must be considerably wider than either Millikan's or my own. The position of the e-value belonging to this single value departs by 1 % from the mean, and the corresponding probable error is given as $\pm 0{\cdot}18$ % (see Fig. 1).

It should be pointed out that the error limits apportioned to each of these three e-values are not computed in the same manner. In Fig. 1, I have indicated by means of horizontal arrows the probable error Δ_p calculated in the usual manner from the formula

$$\Delta_p = \tfrac{2}{3}\sqrt{\frac{\Sigma\Delta^2}{n(n-1)}},$$

where Δ is the deviation from the mean and n the number of values obtained. The arithmetical mean error, Δ_m, is given by

$$\Delta_m = \frac{\Sigma\,|\,\Delta\,|}{n}.$$

Millikan's published error limits, Δ_a, agree with the value calculated from the relation

$$\Delta_a = \sqrt{\Delta_p{}^2 + \Sigma\Delta_s{}^2},$$

where the Δ_s are the systematic errors estimated

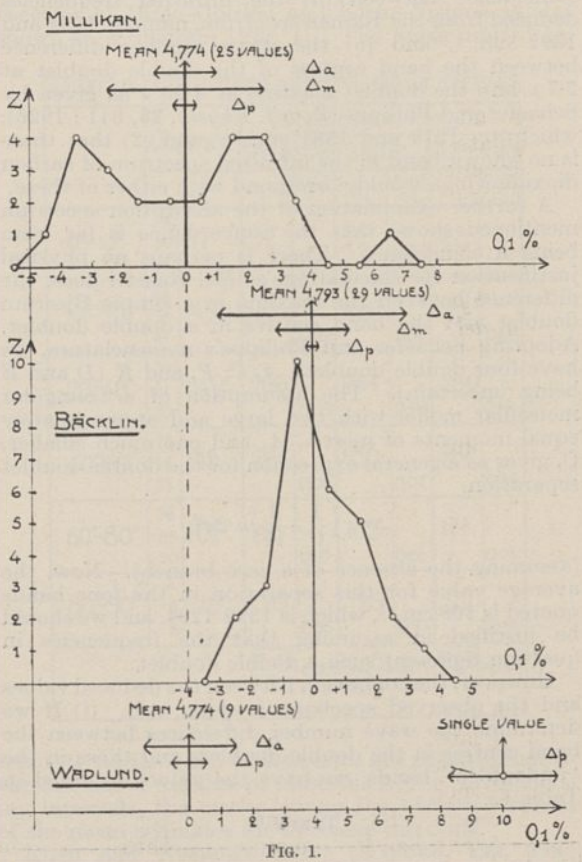

FIG. 1.

from the method used. In my case I have, for the purpose of this calculation, taken

$$\Delta_a = \sqrt{\Delta_m{}^2 + \Sigma\Delta_s{}^2},$$

Δ_m being much greater than Δ_p (see Fig. 1). It would require too much space here to explain in detail the error calculations of Wadlund. For this I must refer to his paper. The diagram is perhaps sufficient.

In my opinion it is of more physical significance to carry out such error calculations with the arithmetical mean error Δ_m, than with the so-called probable error Δ_p, which is commonly used without the necessary analysis of the error distribution obtained.

From the accompanying diagram it is, I believe, clear that from the experimental evidence we can scarcely decide whether 136 or 137 is the better value for Eddington's ratio, especially since h is not known with the same degree of accuracy as e. Moreover, it

should be remembered that the value of h is obtained with the aid of a value of e.

As to the Rydberg constant R, agreement between the spectroscopic value and that calculated from other physical constants is a criterion not only of the value of e but also of the other physical constants involved (h, e/m).

ERIK BÄCKLIN.

Physical Laboratory of the University,
Upsala, Sweden, Feb. 15.

The Raman and Infra-Red Spectra of Carbon Dioxide.

MR. RASETTI'S examination of the Raman spectrum of carbon dioxide as reported in his letter in NATURE of Feb. 9 is of extreme interest. He points out (1) a coincidence between (*a*) the infra-red frequencies deduced from the Raman spectrum, namely, 1284 and 1392 cm.$^{-1}$, and (*b*) the wave number difference between the band centres of the double doublet at 2·7 μ and the doublet maxima at 4·25 μ as given by Schaefer and Philipps (*Zeit. f. Physik*, **36**, 641 ; 1926), which are 1279 and 1381 cm.$^{-1}$; and (2) that there is no known band in the infra-red spectrum of carbon dioxide which would correspond with either of these.

A further examination of the absorption spectrum mentioned shows that the concordance is far from being a coincidence. There is perhaps no physical justification for calculating, as Mr. Rasetti does, the difference between the maxima in a simple Bjerrum doublet and the band centres in a double doublet. Adopting Schaefer and Philipps's nomenclature, we have four double doublets, A, C, F, and K (D and E being uncertain). The assumption of a triangular molecular model with two large and approximately equal moments of inertia, A, and one much smaller, C, gives as a general expression for the double doublet separation,

$$\Delta\nu = \left(\frac{1}{C} - \frac{1}{A}\right) h/2\pi^2$$

(assuming the absence of a zero branch). Now, the average value for this separation in the four bands quoted is 108 cm.$^{-1}$, which is 1392-1284, and we should be justified in assuming that the frequencies in question represent such a double doublet.

However, the connexion between the deduced values and the observed spectrum is closer still. (i) If we determine the wave number differences between the band centres in the double doublets and those in the 'undoubled' bands, we have the values recorded in Table I.

TABLE I.

Bands . . .	$C \longrightarrow I$.	$K \longrightarrow B$.	$B \longrightarrow A$.
$\Delta\nu$ in cm.$^{-1}$ {	1262	1293	1264
	1375	1393	1368

These values are of the same order as the deduced frequencies. (ii) If we perform the same operation on the double doublets themselves the agreement is exact, within the experimental error, $F \longrightarrow A$ giving 1388 and 1282 cm.$^{-1}$. (iii) The frequency difference between the undoubled bands is a simple fraction of one of these frequencies ; thus $B \longrightarrow H$ is 687 cm.$^{-1}$ (approximately $\frac{1}{2} \times 1392$), and $E \longrightarrow D$ is 637 cm.$^{-1}$ (approximately $\frac{1}{2} \times 1284$). There must consequently be some simple relationship between the double doublet separations and the band centre separations ; and we actually find in the two frequencies deduced from the Raman spectrum, that if the former is taken as 107 cm.$^{-1}$, we have $1391 = 13 \times 107$, and $1284 = 12 \times 107$.

This fact is rendered more prominent by a reconsideration of the emission spectrum as determined by the writer in conjunction with Mr. K. H. Lih (Bailey and Lih, NATURE, **121**, 941 ; 1928). To account for the regularities in this spectrum, we assumed that the bands could be represented as multiples of a fundamental frequency given by $\nu_0 = 16 \times 10^{11}$, or in wave numbers, 53·5 cm.$^{-1}$, *i.e.* $\frac{1}{2} \times 107$, the half-value being adopted to provide for the just perceptible resolution of the band at 2·84 μ. Now, if we accept the possible presence of a band at 1284 cm.$^{-1}$ (Eucken, *Zeit. f. Physik*, **37**, 714 (1926), it is interesting to note, postulated the existence of an optically inactive frequency at 7·86 μ, *i.e.* 1272 cm.$^{-1}$), the emission spectrum can be represented in a very simple manner, as will be seen by a consideration of Table II.

TABLE II.

No. . .	1	2	3	4	5	6	7	8
λ in μ . .	1·46	1·70	1·99	2·40	2·84	3·12	4·46	(7·80)
ν in cm.$^{-1}$ obs.	6850	5890	5027	4167	3524	3206	2243	—
ν in cm.$^{-1}$ calc.	6848	5885	5029	4173	3531	3210	2247	(1284)
n . . .	64	55	47	39	33	30	21	12

The calculated wave numbers are obtained by multiplying $\nu_0 = 107$ cm.$^{-1}$ by n ; in particular the bands 8, 7, 6, and 4 now become members of a series represented by $3\nu_0(1 + 3m)$. The above results were obtained with a rocksalt prism spectrometer ; it is proposed to re-examine this spectrum with greater resolution and at higher sensitivity, when possibly other members of the series may be identified. It is difficult at the present to see the underlying physical significance of the above results.

C. R. BAILEY.

The Sir William Ramsay Laboratories of
Inorganic and Physical Chemistry,
University College, London, W.C.1.

The Fulcher Bands of Hydrogen.

IN a communication just published (in the *Proceedings of the Royal Society of Edinburgh*) I have shown that the Fulcher bands of hydrogen can be arranged in three branches (P', Q, and R'), the Q branches being identical with those of Richardson. The P' and R' branches have an initial level differing from that of the Q branch, while all three have a common final level, a fact proved conclusively by the intercombinations found to hold between them. This shows the final state to be an S state, as Birge has predicted.

It is of interest to inquire how these hydrogen bands fit in with the new mechanics, and in particular to determine the constant σ in the term form

$$B\{j(j+1) - \sigma^2\}.$$

An analysis of the bands shows that the terms fit this form provided j is given integral values. This is as it should be according to Mulliken's theory, if the emitting molecule is that of neutral H_2 (odd multiplicity). The lowest lines are R' (0), Q (1), and P' (2), which shows that σ'' is zero in the final terms, as we should expect for an S state.

While the major part of the term is clearly of the form just given, a preliminary examination of the term-differences showed that an appreciable 'correction term' in the fourth power of j (or j_k) is present. Such a term is to be expected on the old theory. Unfortunately, no general expansion for the band terms on the new theory is available. At the sug-

gestion of Prof. H. S. Allen, the following tentative term-formula was adopted :

$$F(j) = \Sigma X_n\{j(j+1) - \sigma^2\}^n,\ n = 1, 2, \ldots$$

Here in the usual notation, $X_1 = B$, $X_2 = D$, . . . In using this formula we need only take into account as many terms as are likely to be required. Actually, we may obtain a good fit for the hydrogen bands by taking into account only the first two terms ($n = 1$ and 2). Such a two-term formula has in fact been found to give a good fit for bands consisting of a large number of members in the case of the blue-green bands of Na_2 ($^1P \longrightarrow {}^1S$) described by Loomis and Wood.

A least-square determination of the constants of the Fulcher null band ${}_0{}^a{}_0$, taking into account the first four terms of the above formula, yields the following values for the final constants :

$$B'' = X_1'' = 33{\cdot}38879 \quad \text{cm.}^{-1},$$
$$D'' = X_2'' = -0{\cdot}0229274 \quad \text{cm.}^{-1},$$
$$X_3'' = 4{\cdot}8565 \times 10^{-5} \text{ cm.}^{-1},$$
$$X_4'' = -3{\cdot}1250 \times 10^{-7} \text{ cm.}^{-1}.$$

The initial constants agree in sign and magnitude with the above. Moreover, the two values of B' obtained for the initial state, one for the Q branch and the other for the P' and R' branches, differ sufficiently to allow the initial constant σ' to be determined within narrow limits. Its value comes out as $\frac{1}{4}$, the actual determination being 0·2506. This result is curious, and points to some, as yet unexplained, peculiarity of the term-form.

With this value of σ' we obtain

$B_A' = 29{\cdot}60537$ cm.$^{-1}$ for the Q series
and $B_B' = 29{\cdot}84408$ cm.$^{-1}$ for the P' and R' series.

It may be pointed out that in the case of the $^1P \longrightarrow {}^1S$ bands of Na_2 these constants only differ by 0·00001 cm.$^{-1}$. Thus, hydrogen seems to present possibilities for band analysis which are lacking for the heavier molecules.

It is hoped to discuss the Fulcher bands in greater detail in a future communication.

IAN SANDEMAN.

Physical Laboratory,
George Heriot's School, Edinburgh.
Feb. 1.

The Angular Distribution of Compton Recoil Electrons.

UP to the present the 'intensity-problem' of the Compton theory has remained unsolved. Many hypotheses have been put forward, and there exist two different solutions based on the new quantum mechanics ; experiment, however, has not given any definite decision in favour of either solution.

There are two ways of experimental test : the investigation of the angular distribution of the secondary quanta (scattered radiation), or the study of secondary recoil electrons. In both cases the decisive information may be obtained only by using very hard rays, that is, γ-rays. Wilson's cloud expansion method presents essential advantages in this respect. The spectral distribution of the secondary β-rays emitted under the recoil angles $\delta < 20°$ is known from my measurements published in 1927 (*Zeit. f. Phys.*, B. **43**, 354). More detailed data were reported at the conference on β- and γ-ray problems (Cambridge, July 1928). These data enable one to determine the corresponding statistical weights of the different spectral components of the inhomogeneous radiation used for each given distribution examined. The results of this comparison are thus independent of the supposed distribution of intensities in the primary spectrum; this supposition in most cases being based on very untrustworthy data taken from an outside series of observations.

In the following table the angular distribution of a thousand β-ray tracks measured in the course of the last one and a half years (observed in the gas under the action of a narrow beam of γ-rays filtered through 3·5 mm. of lead) is compared with the results of calculation according to three different theoretical formulæ. In each individual case the recoil angle has been determined with sufficient accuracy by measuring Wilson's photographs on Pulfrich's stereocomparator. The figures enclosed in brackets in the column of observed values correspond to three separate series of measurements, including 408, 298, and 305 tracks each. The figures belonging to the first series are reduced in the proportion of 300 : 408. The comparison with the data supplied by the latest theories of Dirac–Gordon and Klein–Nishina is also shown in a diagram (Fig. 1). The areas limited by

Numbers of recoil electrons in different angular intervals.

	Observed		Calculated according to					
			Klein-Nishina		Compton		Dirac-Gordon	
	n_o		n_1	$\frac{\lvert n_1-n_o\rvert}{n_1}$	n_2	$\frac{\lvert n_2-n_o\rvert}{n_2}$	n_3	$\frac{\lvert n_3-n_o\rvert}{n_3}$
0°–10°	39 34 44	117	92	0,27	72	0,62	48	1,44
10°–20°	48 54 47	149	152	0,02	148	0,01	93	0,60
20°–40°	76 81 85	242	266	0,09	264	0,08	280	0,14
40°–60°	75 66 74	215	224	0,04	230	0,07	287	0,25
60°–80°	56 55 50	161	146	0,10	162	0,01	171	0,06
80°–90°	6 8 5	19	20	0,05	26	0,27	22	0,14
			$\frac{\lvert n_1-n_o\rvert}{n_1} = 0{\cdot}095$		$\frac{\lvert n_2-n_o\rvert}{n_2} = 0{\cdot}177$		$\frac{\lvert n_3-n_o\rvert}{n_3} = 0{\cdot}44$	

separate parts of the broken lines are proportional to the calculated number of electrons in the corresponding intervals, the circles giving the observed values of the mean ordinates for the same intervals.

Klein and Nishina's letter (NATURE, **122**, 398 ; 1928) contained a comparison of the intensity curves of scattered radiation calculated on the three theories mentioned above. In this case the curves differ considerably only in the region of large scattering angles, where the intensities of the scattered rays are extremely weak ; therefore any definite decision in favour of either curve is scarcely to be expected. The observed angular distribution of the secondary electrons, however, diverges from Dirac–Gordon's curve to a large degree and is definitely in contradiction to their theory.

Of all the three theoretical results compared above, Klein–Nishina's formula is in the best agreement with our data. The discrepancies, however, exceed even in this case the probable statistical deviations. These discrepancies also cannot be attributed to experimental errors only. We are evidently confronted with systematic deviations, which will be shown more clearly in a detailed paper shortly to be published.

The question of the angular distribution of secondary radiation is intimately connected with the problem of the determination of the scattering absorption coefficient as a function of wave-length. This relation is implicitly contained in the formulæ of Dirac–Gordon and Klein–Nishina, which determine the above dis-

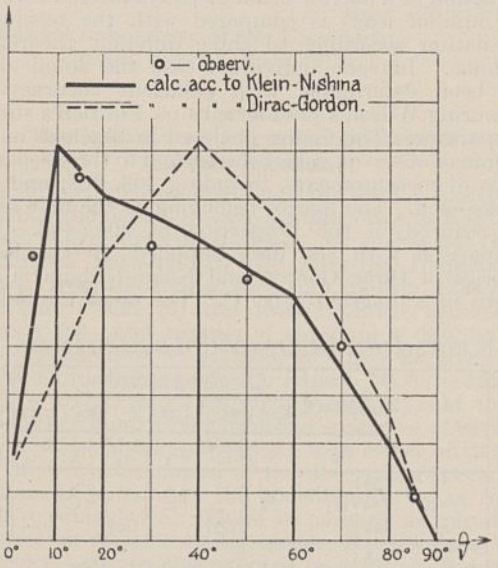

FIG. 1.—Distribution of recoil electrons.

tribution. The result of the comparison quoted above can be therefore considered as a serious argument against the scattering absorption formulæ deduced by Dirac and Gordon, as well as against the estimations of the wave-length of ultra-γ-rays based on this deduction.

D. SKOBELTZYN.

The Physical-Technical and
Polytechnical Institutes,
Leningrad, Jan. 22.

The Complexity of the *K*-β′ Line of X-ray Spectra.

RECENT measurements of the X-ray spectrum line K-β', and the separation of this line from the K-β_1 line, make it remarkable that their separation had not been attained in the course of earlier measurements (M. Siegbahn, V. Dolejšek, *Zeit. f. Phys.*, **10**, 159; 1922), especially in the case of elements of low atomic number, where the difference between K-β' and K-β_1 is about 6 X.U.

N. Seljakov and A. Krasnikov (*Zeit. f. Phys.*, **33**, 601; 1925. NATURE, **117**, 554; 1926) distinguished the line K-β' for the element of atomic number 25 (manganese), and G. Ortner (*Akad. d. Wiss. Wien*; 1926. NATURE, **117**, 823; 1926) separated it in the case of some compounds of iron and cobalt. These investigations show that only with certain compounds are these lines distinguished, and this has suggested to us that, in the case of lower elements, the diffusion of this line is dependent upon the state of chemical combination.

We have now examined different manganese compounds with the object of determining this dependence, if possible, but within the limits of precision no relationship between the state of chemical combination and the breadth (diffusion) or displacement of the line has been found, and in all cases the K-β' line is readily distinguished (Fig. 1).

The microphotometric curves of the lines from different compounds make it apparent that the ratio of the lines K-β_1 : K-β' becomes greater for oxides than for free elements, in which case it coincides with the results of Seljakov and Krasnikov. The value of this ratio, in the investigations of Seljakov and Krasnikov, is found to be 2 : 1. The determination of the value of the intensity ratio from our measurements is not considered here; this is being investigated independently with J. Hrdlička, and the results will be presented in due course.

Although we could not ascertain, within the limits of our measurements, any influence of the chemical combination on the displacement of the lines, we

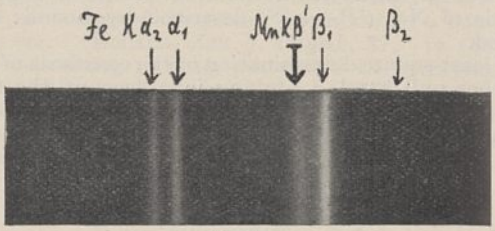

FIG. 1.

cannot say that it does not exist. Such quite small influence could manifest itself with the compounds—which are not stable on the anticathode—by the diffusion (broadening) of the lines. To eliminate such possible source of error, we used only the free metals for our measurements of the K-β' line of other elements.

The measured differences of this line from the K-β_1 line are shown in Fig. 2.

The curves (a, a) in this Fig. show also the different breadth of this line K-β' in the case of different elements. For the lower elements the breadth is greater—twice greater—than that of the K-β_1 line. With these elements we have found that the K-β' line is two

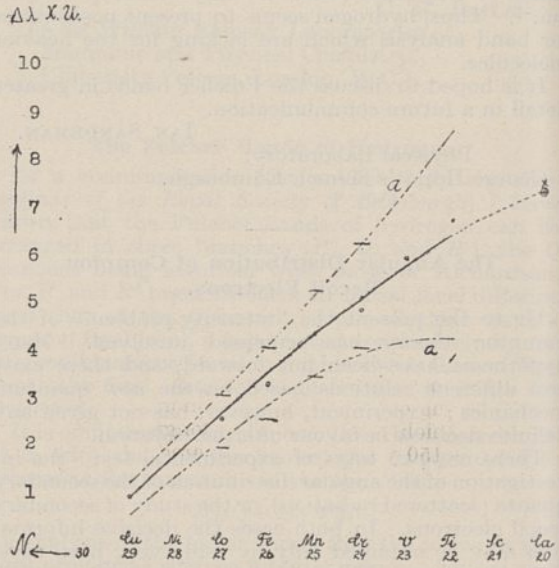

FIG. 2.

unresolved doublet-lines, which in the case of the higher elements are superimposed. As is well known, the difference $\Delta\lambda$ between the K-β' and K-β_1 increases with the decreasing atomic number. As one can see from Fig. 2, the breadth of the line increases simultaneously with the decreasing atomic number. That is the reason why it is so difficult to distinguish K-β' with elements of lower atomic number ($\Delta\lambda = c.$ 6 X.U.) as compared with those of higher elements ($\Delta\lambda = c.$ 2 X.U.).

We have measured, separating this line in all the

elements mentioned, the difference $\Delta\lambda$ from the middle of the lines contrary to our previous measurements of the edges of the emission bands. Therefore we can determine quite surely the energy frequency difference $\Delta\nu/R$ of the K-β_1 and K-β'. This difference of frequency resulting from our measurements $\Delta\lambda$ does not coincide with the values calculated from the frequency difference of the M_{II} and M_{III}-levels, and consequently these two lines cannot both be due to transition $K \rightarrow M_{II}$, $K \rightarrow M_{III}$, in agreement with the opinion of G. Ortner (*l.c.*) and D. Coster and M. F. Druyvesteyn, (*Zeit. f. Phys.*, **40**, 735 ; 1927).

Further, from our measurements we can see, by following the course of the $\Delta\lambda$ of these lines, their dependence on the atomic number (Fig. 2), that there is no peculiar change in the region of the iron family.

In conclusion, we consider that the K-β' is a complex line, and it is impossible to arrange the line in the scheme of Bohr and Coster. The origin of this line is as yet unknown.

V. DOLEJŠEK.
H. FILČÁKOVÁ.

Physico-Chemical Institute,
Charles' University,
Prague, Jan. 9.

Dicœcism in *Ranunculus acris*.

DURING the course of a cytological investigation of the reproductive organs of dicœcious and intergrade forms of *Ranunculus acris* L., in connexion with the genetical work of Mr. E. M. Marsden-Jones and Dr. W. B. Turrill, a matter of some general interest has arisen, which it is thought advisable to put on record forthwith.

Examination of a hermaphrodite flower showed that there are two distinct and successive phases in the development of the flower: first, a male or anther phase, marked by the commencement of physiological activity in the tapetum, and continuing until the formation of mature pollen grains; and secondly, a female or ovule phase, commencing with the growth of the ovules and continuing until the formation of mature embryo sacs. This development of male and female tissues in successive phases is the normal arrangement in hermaphrodite flowers, the interval between the two reduction divisions being constant for any given species, the variations between different species being correlated with the amount of ovular development therein.

In the flowers of a 'female' plant of *R. acris* the male and female phases coincide completely, the reduction divisions in anthers and ovules commencing at the same time. The two processes are not able, apparently, to proceed concurrently, and complete failure of the tapetum in the anthers is probably due to lack of sufficient food supplies reaching them from the main axis.

Several of the forms of *R. acris* intermediate between 'normal hermaphrodite' and 'female' were also examined, and there was found to be a direct correlation between the extent of overlap of male and female phases on one hand, and the amount of good pollen produced on the other. In each case the commencement of growth in the ovules was associated with the sudden failure of the tapetum in the anthers of the same flower, with cessation of pollen development as a sequel.

It is conceivable that this time factor will explain the occurrence of complete and partial dicœcism in many species; in those plants where all grades from staminate to pistillate flowers are found, there are indications that the appearance of partial or complete 'male' forms, with a corresponding sterility of the ovules, may be explained by variations in the vascular structure of the flowers under consideration.

A detailed account of the influence of this time factor in *R. acris* and some other species is being prepared for publication.

R. O. WHYTE.

Botany School,
Cambridge.

Floating Mercury on Water.

WHILE trying, recently, a process for cleaning mercury, I obtained some small globules floating on water, in the same way that a waxed needle floats. The mercury had been shaken with sulphuric and chromic acids, and was finely subdivided; on pouring carefully into water, a few globules floated. Some of these ran together and coalesced, in deep depressions in the surface; the largest floating globule was about 0·5 millimetre diameter. The flotation was quite

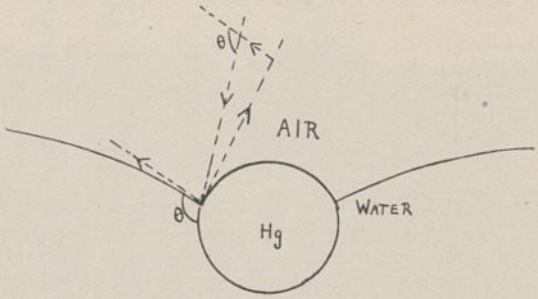

FIG. 1.

stable, and was not destroyed even by contaminating the surface with a drop of oleic acid, which spreads to a film reducing the surface tension to about 46 dynes per centimetre. The accompanying rough sketch (Fig. 1) shows the directions of the relevant surface tensions dotted in.

The tensions of clean mercury against air (475 dynes per centimetre) and against water (375) differ by more than the surface tension of clean water, so that it would be impossible for clean mercury to float on water; the water would spread over the whole drop with zero contact angle. It is, however, well known not to be easy to get mercury clean enough for water to spread on it. The condition of flotation is that the contact angle, θ, should be definite, and for stable flotation it should be large. The mercury-air tension must be reduced to well within 46 dynes per centimetre of the mercury-water tension, for flotation on the surface contaminated by oleic acid. Since the mercury had been emulsified in the mixed acids, probably even the mercury-water tension had been a good deal reduced; therefore the mercury-air tension seems to have been reduced by an amount of the order one or two hundred dynes per centimetre.

I have never seen a description of the floating of mercury, and should be interested to hear if there is any record of it, or if anyone else has observed it.

N. K. ADAM.

The University,
Sheffield, Feb. 12.

The Electric Moment of Primary Alcohols.

OF late the question of the permanent dipole moment of polyatomic molecules has been considered of great importance in order to elucidate the nature of forces that interact between the constituent atoms of the molecules.

The electric moments of a number of primary and secondary alcohols have been determined in this

laboratory by Mr. P. C. Mahanti and Mr. R. N. Das Gupta with the Nernst bridge method, and the results clearly indicate that, so far as the *primary* alcohols are concerned, they have practically the same dipole moment in them.

Substance.	Chemical Formula.	$\mu \times 10^{18}$.	Observers.
1. Methyl alcohol .	CH_3OH	1·64 1·61	F.W.[1] J.[2]
2. Ethyl ,, .	C_2H_5OH	1·64 1·63	F.W. W.[3]
3. Propyl ,, .	C_3H_7OH	1·66	F.W.
4. Butyl ,, .	C_4H_9OH	1·65 1·62	L.[4] M.D.[5]
5. Hexyl ,, .	$C_6H_{13}OH$	1·64	,,
6. Octyl ,, .	$C_8H_{17}OH$	1·62	,,
7. Noxyl ,, .	$C_9H_{19}OH$	1·60	,,
8. Decyl ,, .	$C_{10}H_{21}OH$	1·63	,,
9. Duo-Decyl ,, .	$C_{12}H_{25}OH$	1·62	,,
10. Benzyl ,, .	C_6H_5OH	1·66	W.
11. Iso-propyl alcohol	$CH_3CH(OH)CH_3$	1·78	M.D.
12. Iso-Butyl ,, .	$(CH_3)_2CH \cdot CH_2(OH)$	1·79 1·72	,, L.
13. Iso-Amyl ,, .	$(CH_3)_2CH \cdot CH_2CH_2OH$	1·82 ? 1·76 1·85 ?	M.D. L. W.

[1] F.W. Falckenberg and H. Weigt.
[2] J. M. Jona.
[3] W. J. W. Williams.
[4] L. Luise Lange.
[5] M.D. P. C. Mahanti and R. N. Das Gupta.

Since these alcohols are produced by the substitution of one atom of hydrogen by an OH-group in the normal hydrocarbon molecules, it is reasonable to infer that the dipole moment is due to the polarisation of the oxygen atom by the hydrogen atom on one hand and by the carbon atom on the other. In other words, it may be stated that the binding forces acting on the carbon atom reacting with the oxygen are just the same whether the chain is long or short, open or closed. It may also be pointed out that the carbon atoms associated with the CH group forming the iso-alcohols have quite different binding forces leading to different values of the permanent dipole moments. The details of the investigation will be published elsewhere.

P. N. GHOSH.

Applied Physics Laboratory,
University College of Science,
92 Upper Circular Road, Calcutta.

Action between Copper Salts and Glycerol.

A VIGOROUS action occurs when a solution of any of the copper salts (hydrated or dehydrated) in glycerol is heated to about 150° to 200° C.

The salts, with the exception of cupric chloride, are invariably decomposed into metallic copper (fine powder more than 99 per cent pure) and free acid, which may also undergo further decomposition. The decomposition products of glycerol are ethyl alcohol, acrolein (when the salt acts as a dehydrating agent), carbon dioxide, methane, carbon monoxide, and hydrogen, the last two being present only in small quantities.

With cupric chloride instead of metallic copper a white precipitate of crystalline cuprous chloride is obtained. This may be regarded as due to a secondary action set up in presence of copper, hydrochloric acid, and cupric chloride which is still in solution. The action seems to be fairly general, as other polyhydroxy alcohols (glycol, erythritol, and mannitol) give nearly the same result.

It is known (Sabatier and Gaudion, *Compt. rend.*, **166**, 1033-1039; 1918) that glycerol vapour is decomposed into almost the same products mentioned above, at 330° C., in presence of finely divided copper. It is very likely, therefore, that in the present case a proportion at least of the decomposition products are due to the catalytic action of copper.

If, as is generally believed, metallic salts dissolve in polyhydroxy compounds, replacing the hydrogen of the hydroxyl group by the metal, copper and glycerol would form a compound of the formula: $C_6H_{10}O_6Cu_3$. Further, as copper, carbon dioxide, and methane are the chief products of the reaction a possible way of explaining it would be: $C_6H_{10}O_6Cu_3 = 3Cu + 3CO_2 + CH_4 + C_2H_6$, although there is no direct evidence of ethane.

Apart from the theoretical considerations the reaction gives a method for preparing pure, finely divided copper, which is very suitable for catalytic purposes. Even crude copper sulphate yields quite a good product. The method may be also employed for preparing cuprous chloride from cupric chloride, the reduction being quantitative.

A detailed paper on the subject will be published shortly.

B. K. VAIDYA.

The University, Liverpool.

Effect of Electric and Magnetic Fields on the Helium Spectrum.

(BY IMPERIAL WIRELESS SERVICES.)

WITH a nearly uniform magnetic field of fifteen thousand gauss perpendicular to an electric field which varies from zero to fifteen thousand volts per centimetre, I find many lines which are not ordinary Stark components and appear not to be due to impurities. Effects are similar in the corresponding parhelium and orthohelium line groups near the diffuse series lines. For example, strong lines appear on the violet side of 4388 A. and 4026 A. at distances nearly double those of the usual fundamental combination lines of the Stark effect. These well-defined lines show no decided polarisation, and at maximum field are displaced toward the red 0·5 A. and 0·2 A. respectively. At an intermediate value of electric field, components in 4026 group are displaced from the diffuse line 0·25 A., 0·47 A., 0·62 A., 0·78 A., 1·90 A., 2·10 A. The components in positions of usual Stark components of large displacements are relatively diffuse.

That new lines should appear in the presence of crossed fields was first stated by Prof. Bohr. It is now possible to make repeated observations on these, owing to experimental features which will be described in a later paper.

In this research, I have been assisted by Dr. Chalk through a grant from the National Research Council of Canada.

J. S. FOSTER.

McGill University,
Montreal, Mar. 10.

Band Spectrum of Chlorine or Hydrogen Chloride.

FURTHER investigation of the bands described by me in NATURE of Jan. 19, p. 86, leaves no doubt that these were caused by traces of sulphur introduced into the stream of hydrogen by the sulphuric acid wash bottle. They are very similar to the bands described by Johansen (*Zeit. wiss. Photographie*, 11, 20; 1913).

E. B. LUDLAM.

University Chemical Laboratory,
Edinburgh, Mar. 1.

The Transvaal Fossil Human Skeleton.

By Dr. ROBERT BROOM, F.R.S.

AT the end of January last a road party, working in the Springbok Flats about eighty miles north of Pretoria, in excavating calcareous ground to make a road, came across a human skeleton and bones of the extinct buffalo (*Bubalus Bainii*) and of a large antelope. The spot where the bones were found has been visited by Mr. C. J. Swierstra of the Transvaal Museum and Mr. Herbert Lang, and they have taken careful observations of the occurrence. There is a foot and a half of dark reddish-brown surface soil, with below it about six feet of calcareous tufa (Fig. 1). The skeleton was obtained at a depth of three feet from the surface and thus about one and a half feet from the top of the tufa. The bones are for the most part much impregnated with lime and, except the powerful long bones, badly broken. The skull is mostly broken into pieces about the size of half a crown or smaller, but fortunately the mandible is well preserved. In the opinion of Mr. Lang, the man has probably been killed while hunting and his body crushed in the mud by the trampling of a wounded buffalo—not improbably the one whose bones lay near his own. Mr. Swierstra has kindly asked me to make an examination and report on these bones.

FIG. 1.—The quarry where the human remains were found. Mr. Miller, who discovered the remains, is pointing to the layer in the tufa where the bones were found.

The fitting together of the cranial fragments has been a matter of some difficulty, as at present about a quarter of the fragments are missing, and most are so impregnated with lime that it is difficult getting them sufficiently cleaned to fit nicely. Still, enough has been done to give a satisfactory idea of the shape and general character of the skull.

The Transvaal Museum is at present at work going over all the ground to endeavour to obtain all the missing fragments. As this will take a considerable time and will not alter materially any conclusion that can now be come to with regard to the skull, there seems nothing to be gained by delaying, more especially as the press has been largely interested in the matter and has been issuing reports, some of which are not altogether correct.

At present we have almost the complete right side of the skull and much of the left side, but without the basicranial region; and the whole of the face except the frontals and malars is lost. The mandible is practically complete. Of the post-cranial skeleton there are remains of three vertebræ and fragments of many ribs, a fragment of one scapula, half of one clavicle, both humeri but with the ends lost, much of both radii and ulnæ, and much of one hand. There is no trace of the pelvis or sacrum, but both femora are well preserved except that the ends are lost, and there is much of both tibiæ and parts of the fibulæ, with a well-preserved astragalus.

The skull is of the modern type with a fairly large brain. The maximum length is about 195 mm. and the breadth is about 144 mm. The antero-posterior measurement can be relied on as very nearly accurate, but the breadth is less certain, as the fragments of the left side of the skull cannot at present be fitted together, but the greater part of the occiput and frontales are preserved, and the middle line can thus be approximated. The cephalic index is thus about 74. The frontal region slopes, as seen on the photograph (Fig. 2), and is not in the least Neanderthaloid. The frontal bone is narrow, the width at the lower part being about 106 mm. The parietal region is lower than in most modern types of man, and there are no marked parietal eminences. The bones are not unduly thick—the maximum being less than 9 mm.

The mandible is unusually long and very massive, and there is a well-marked chin (Fig. 3). The ascending ramus is very wide, being 48·5 mm. from the front of the coronoid process to the hollow below the condyle. From the condyle to the front of the symphysis is about 141 mm. The symphysis is 17·5 mm. in thickness. The teeth are

relatively small, the three molars measuring only 30 mm. and the molars and premolars together 42 mm. The crowns are badly worn down, and the pattern cannot with certainty be determined. There seems, however, to be no clear evidence of a 5th cusp, except perhaps in *m'*. The under side of the symphysis resembles considerably that of Neanderthal man. The angle of the jaw is extremely thick (7-8·5 mm.) and has prominent muscular ridges.

The limb bones are large and powerful. I estimate the humerus to be about 330 mm. long, but as both ends are lost it is impossible to give the measurements quite accurately. The radius, ulna, and phalanges are all those of a powerfully built man.

The femur can be restored with much probability, only the head and the distal end being unknown. There is considerable resemblance to the thigh bone associated with the Rhodesia skull. The bone is very long and massive; the greatest length is, as near as may be, 500 mm. The shaft measures below the lesser trochanter 36 mm. by 28 mm. The shaft is very considerably curved. The tibia is about 435 mm. in length, and the shaft near the nutrient foramen measures 40 mm. by 30 mm.

A comparison with previously known prehistoric human skulls at once suggests a possible affinity with that of Cro-Magnon man; and with the previously known large-brained South African fossil type, the Boskop man. The present skull, which may be referred to as the "Bushveld skull," resembles both in being large brained and in having a fairly good forehead and quite small supraorbital ridges. The man was also like that of Cro-Magnon,

FIG. 2.—Skull of Bushveld man as restored by R. Broom.

of large stature. But there are some points of striking difference. Cro-Magnon man had a high parietal region: Bushveld man has, like the Hottentots and Bushmen, a relatively low parietal region. This is a point to which most anthropologists pay little attention, but it is in my opinion one of very great importance. Lowness of the parietal region is evidently a primitive character. It is found in *Pithecanthropus*, *Eoanthropus*, Neanderthal man, Rhodesian man, and in Boskop man and in the Bushman of to-day. In Cro-Magnon man, as in most living races, the parietal region is high. There are many other striking points of difference, though possibly Cro-magnon man may be descended from a Bushveld-like type.

Boskop man also has some points of likeness. Both have low parietal regions, but there are few

FIG. 3.—Under side of jaw of Bushveld man with jaws of a Kaffir and a Hottentot for comparison.

other resemblances. Boskop man has prominent parietal eminences: Bushveld man has not. Boskop man has parietals 15 mm. in thickness. The skull of the Bushveld man is nowhere more than 9 mm. The teeth of Boskop man have apparently been large: those of Bushveld man are small. The bones of the Boskop man are much more completely mineralised and probably older, but until a good skull is obtained it will be impossible with certainty to fix its position.

The Bushveld man was certainly the contemporary of the extinct *Bubalus Bainii*. At Hagenstad, in the Orange Free State, we have many human implements in association with the bones of not only *B. Bainii* but also of the extinct *Equus capensis* and of two large extinct antelopes. We are thus probably justified in assuming that the Bushveld man was a member of the race that made the Hagenstad type of implements. These implements, according to the archæologists, are regarded as representative of the middle old stone age of South Africa, and we may thus regard the Bushveld man as the man of the middle Palæolithic period. Of course, at present we are quite unable to date the remains in years. We can only say that they are certainly very old.

There are many reasons for regarding the Korannas, a few of whom still survive in South Africa, as the direct descendants of the Bushveld type of man. For many years I have regarded the Korannas as one of the most important of the surviving races, though hitherto anthropologists have given them very little consideration. From the enormous numbers of implements found in the diamond gravels there must have been a powerful race, numbering tens if not hundreds of thousands, inhabiting the Vaal River valley in prehistoric times. This Bushveld skeleton is the first evidence we have of a man that probably belonged to this race, and it is interesting to find how closely he agrees in many respects with the surviving Korannas of to-day.

Chemiluminescence.[1]

By Dr. ERIC K. RIDEAL.

IN attempting to make the subject matter of this discourse as experimental as possible, it will be impossible to delve in great detail into the molecular mechanism of the reactions. This, I think, is as well, because many of the reactions which should be shown on account of their great beauty are certainly extremely complicated and have not, in fact, been subjected to any but a very superficial examination.

Chemiluminescence may be regarded as the counterpart of photochemical processes. By the absorption of light of suitable frequencies, atoms and molecules may be raised to states of higher initial energy. These excited entities may now undergo a series of changes, the nature of which will depend on a variety of circumstances. They may liberate their absorbed energy in the form of fluorescent light, impart part or all of their energy to a neighbour of another species by a collision, become converted into a metastable more permanent and energy-rich molecule which may afterward revert to the normal form, or suffer some species of chemical reaction such as ionisation, dissociation, or combination.

By suitable modification of conditions one can affect the velocities of chemical reactions over relatively wide ranges, and it is found that in many strongly exothermic reactions there exists a narrow range of relatively high velocities which is chemiluminescent. Closer examination indicates that practically all these reactions are complex in that they are accompanied not only by the emission of radiation localised in some portion of the spectrum but also by a rise in temperature. It is by a study of the chemiluminescent portion of such composite reactions that we may hope to gain a further insight into the molecular mechanism and the operation of the process of chemical activation.

We may with some degree of assurance assume that chemiluminescence is in many cases the result of liberation of chemical energy in a form similar to that of fluorescent energy, and we have noted that fluorescence is the result of decay of a number of excited molecules, the excitation being produced in this case by the absorption of radiation. Thus conditions suitable for chemiluminescence result in reactions in which large numbers of excited molecules are produced by chemical reaction, under conditions such that at least a fraction of the excited molecules can revert to the normal form with the emission of radiation. Excluding thermally accelerated exothermic reactions, a large group of auto accelerating reactions exhibit chemiluminescence; these are usually designated as branching chain reactions, and we shall observe that there are several hypotheses as to the nature of such reactions and at least two distinct light-producing processes.

A typical reaction of this type is the oxidation of phosphorus—one of the oldest chemiluminescent reactions observed with a definite substance, although the chemiluminescence of fireflies, decaying wood and certain bacteria and fish have long been commented on and were formerly attributed to the action of vital forces. The name phosphorus arose from a confusion of chemiluminescence with the phosphorescence of the impure barium sulphide, the so-called lapis Bologniensis. We may symbolise the fact that the reactions proceed in branching chains in a number of ways: thus, denoting the reactants by A_2 and B_2 and the molecules in the excited state by A'_2 we might postulate as the mechanism

$$(a)\quad A'_2 + B_2 \rightarrow A'_2B_2 \rightarrow (A'B)_2 \rightarrow AB' + AB'$$
$$AB' + A_2 \rightarrow AB + A'_2$$
$$(b)\quad A_2 + B_2 \rightarrow AB + A + B$$
$$A + B_2 \rightarrow AB + B$$
$$B + A_2 \rightarrow AB + A$$

In both cases the conditions that one elementary reaction shall produce at least two reacting molecules so as to effect an auto accelerated reaction are fulfilled, but whilst in the first the chemiluminescence is imagined to result from the return of the excited species AB' or A'_2 to the normal, in the second it is supposed to take place through some type of atomic combination; for example, $2A \rightarrow A_2$ or $A + B \rightarrow AB$, a mechanism which has been more fully investigated in a series of reactions which will be discussed later.

We may note that, in addition to these types of chain mechanism, there exists a third in which it is imagined that a certain number of reaction centres are formed, by some identified as ions; around these reaction centres reaction takes place and more reaction centres are formed. As a hypothetical case we might imagine that in a hydrogen chlorine mixture a positive ion is formed, and around this ion a number of hydrogen and chlorine molecules are held by electrostatic forces. On neutralisation of the ion, the energy set free effects the combination of the small group of molecules around the ion and chemiluminescence and the formation of a few more ions result.

That in the oxidation of phosphorus, sulphur, and probably many other substances, the chemiluminescence is the result of some such type of chain mechanism can scarcely be doubted, but it is difficult in fact to state to which of these three possible types any one reaction definitely belongs. It is perhaps significant that in the oxidation of phosphorus a number of the lines in the complex band spectrum of the emitted light are identical with those of ionised oxygen. A typical phenomenon observable in the chain or cluster reactions is that of inhibition by small quantities of inhibitors. We may note the ease with which inhibitors such as benzene and ether inhibit the glow of phosphorus, a confirmation of the nature of the chemical process at work. Many other vapours exhibit chemiluminescence on oxidation, a fact noted by Sir Humphry Davy; thus the vapours of ether and carbon disulphide can readily be caused to undergo cold luminous combustion. Under more restricted

[1] From a lecture, with experiments, delivered at the Royal Institution on Friday, Feb. 15.

conditions, the union of acetylene and chlorine and the oxidation of the hydrocarbons can be made to exhibit chemiluminescence, and although in these reactions the thermal changes are relatively large, yet since the light emitted is definitely chemiluminescent, it seems almost certain that, contrary to the views of several investigators in these reactions, one cannot be dealing exclusively with thermally accelerated as opposed to branching chain or cluster accelerated reactions; excited molecules, atoms, or reactive clusters must be taking part in the reaction.

Far more complicated, but equally beautiful, are a number of chemiluminescent reactions taking place in solution. The well-known Wedekind reaction, the interaction of chlorpicrin and phenyl magnesium iodide exhibiting a green chemiluminescence, requires the use of a draught chamber, but the cold oxidation of pyrogallol formaldehyde mixture exhibiting an orange-red light, due to Trautz and Schorigin, blue luminescence in the oxidation of 3-aminophthalic hydrazide and the green of triphenyl glyoxalin (Lophin) are all brilliant and readily demonstrated. These reactions are characterised by a high temperature coefficient—some 2-3 for a rise of 10° C.—an indication of the chemical origin of the light-emitting system.

It is somewhat remarkable that few people have observed the beautiful chemiluminescence exhibited by the interaction of chlorine or chromyl chloride with ammonia, although I suppose the former reaction is demonstrated annually in at least one of the classes in every school where chemistry is taught.

Sir James Dewar noted a chemiluminescence when ozone is brought into contact with organic matter. Such chemiluminescence is particularly marked in the oxidation of certain dyestuffs both fluorescent and non-fluorescent; we may observe the phenomenon in a brilliant form in the case of alcoholic solution of both eosin and safranin. The chemiluminescent light is not identical with the fluorescent light of these dyes. This reaction may be modified so as to give a very vivid demonstration of the action of inhibitors. By addition of a small quantity of hydroquinine to the alcoholic solution of safranin we note that on exposure to ozone no chemiluminescence results, the dyestuff is not oxidised, but after a minute or two the hydroquinine is completely oxidised and the brilliant green glow of the dyestuff undergoing oxidation spreads over the bulb.

We have already indicated the possible connexion between chemiluminescence and reversed photochemical action, postulating in both cases the generation of an excited molecule formed in the former by chemical and in the latter by radiant processes. This analogy may be pursued somewhat further by a consideration of the mechanism of photochemical sensitisation and its reversal. In cases of photochemical sensitisation, a molecule excited by the absorption of radiation conveys by collision part or all of its energy to a molecule of another species which afterwards undergoes chemical reaction. The beautiful experiments of Franck and Cario in forming chemically reactive hydrogen by sensitisation with mercury vapour excited by the line $\lambda 2537{\cdot}4$ A. may be cited as a case of photochemical sensitisation. A similar complementary reaction in chemiluminescence has been observed by Kautsky, who showed that the energy liberated as chemiluminescence in the oxidation of the suboxide of silicon, siloxene, could be transferred to certain dyestuffs causing them to become excited and undergoing fluorescence. Only those dyestuffs such as fluorescein and eosine which are adsorbed by the crystals of the siloxene can be made to fluoresce, an indication that the energy necessary for excitation of the dyestuff molecule must be transmitted by collision from one of the surface molecules of the solid reacting siloxene, which in turn must pass through the stage of an excited molecule during oxidation.

The experiments initiated by Haber and Zisch on the interaction of the alkali metals with halogens and halides have more recently been re-examined by numerous investigators, notably Kondratjew, Ljalikoff, and Polanyi; these all exhibit beautiful chemiluminescent effects. The interaction of sodium and iodine vapour and of potassium and iodine demonstrate the various phenomena to be observed in these reactions, and analysis of the radiation, as well as of the distribution on the tube walls of the salt formed, gives us a clue to the mechanism of the reaction. In the interaction of sodium vapour and iodine we may compute the thermal changes accompanying all the possible reactions.

$$\begin{aligned}
&(1)\ \mathrm{Na} + \mathrm{I_2} = \mathrm{NaI} + \mathrm{I} + 33{\cdot}5\\
&(2)\ \mathrm{Na} + \mathrm{I} = \mathrm{NaI} + 68{\cdot}7\\
&(3)\ \mathrm{Na_2} + \mathrm{I} = \mathrm{NaI} + \mathrm{Na} + 51\\
&(4)\ \mathrm{I} + \mathrm{I} = \mathrm{I_2} + 35{\cdot}2
\end{aligned}$$

It is observed that the *D* line only is emitted, corresponding to a chemiluminescent emission of 48·3 cal. Of the four reactions listed above, only two are accompanied with sufficient energy for the liberation of the *D* line, namely, (2) and (3). A further observation that the chemiluminescence possesses in this case a negative temperature coefficient, suggests that only one of these reactions, namely, $\mathrm{Na_2} + \mathrm{I} = \mathrm{NaI} + \mathrm{Na}$, is responsible for the chemiluminescence observed in the gas phase, and that neither (2) nor (4) takes place in the gas phase except in a reaction more involved than a bimolecular one. The tube walls catalyse both reactions (2) and (4) effectively. The surface catalysed reaction is clearly observed in the union of potassium and iodine, for the reaction (3) above does not occur to an appreciable extent when sodium is replaced by potassium on account of the low concentration of diatomic potassium molecules in the vapour of the element.

The bulk chemiluminescent processes can accordingly be represented as

$$\begin{aligned}
&\mathrm{Na_2} + \mathrm{I} \rightarrow \mathrm{NaI'} + \mathrm{Na}\\
&\mathrm{NaI'} + \mathrm{Na} \rightarrow \mathrm{Na'} + \mathrm{NaI}\\
&\mathrm{Na'} \rightarrow \mathrm{Na} + h\nu
\end{aligned}$$

Chemiluminescent methods may be employed not only to identify as noted above the nature of

the molecular processes involved in a chemical reaction, but also to fix, within certain limits at least, the energy of dissociation of certain gases. Thus, the simple dissociation process,

$$H_2 \rightleftarrows 2H,$$

in reality must be much more complicated in operation than the unimolecular bimolecular dynamic equilibrium postulated by this equation given in the text-books. Whilst the efficiency of collision in causing reaction of complex molecules such as $2NO_2 \rightleftarrows N_2O_4$ is usually high, that of atomic recombination is very low, and if we regard a pair of normal atoms in close proximity to one another as the extreme case of dissociation, the absence of an electric moment in the system forbids the quantised emission of radiation. Thus reactions such as $2H \rightarrow H_2$, $2Br \rightarrow Br_2$, only occur in the presence of a third body or a surface, and the energy of combination transmitted to the third body is frequently emitted as chemiluminescence, a phenomenon readily observed with atomic hydrogen. The energy of combination of atomic hydrogen is found to be sufficiently great to excite the OH molecule to emission, but not the mercury line λ2537 A. in mercury atoms; this places the energy of dissociation of hydrogen between 94,000 and 112,000 cal. per gram molecule.

Atomic hydrogen, readily prepared by Wood's method, is a convenient source of many chemiluminescent experiments. The afterglow of a number of gases, notably oxygen, nitrogen dioxide and nitrogen, when excited by the electric discharge, may all be regarded as chemiluminescent reactions in that the gases possess enhanced chemical reactivity in the glowing state. The glow of nitrogen dioxide and nitric oxide and the afterglow of Lord Rayleigh's active nitrogen are particularly brilliant, but the chemical processes involved are at present obscure. It seems at least definitely established that active nitrogen contains at least two chemically reactive species, both atoms and excited molecules. The cohesion of solid surfaces may be regarded as a species of chemical reaction in the solid state, and several of these reactions are found to be chemiluminescent; although frequently classified as tribo- or crystalo-luminescent reactions, the crystallisation of arsenious oxide and sugar exemplify this class of reaction.

Other quasi-chemical reactions which are luminescent include the fluorescence and phosphorescence excited in various substances, especially in solid solutions, by electron bombardment, some of the effects produced by the bombardment of minerals such as kunzite by high speed electrons being particularly brilliant. Finally, we may observe the chemiluminescence obtained with certain bacteria such as *B. fluorescens* and the reaction between luciferin and luciferase, the basis of biological light.

Obituary.

MR. S. S. BUCKMAN.

THE son of Prof. James Buckman, a well-known botanist and geologist of his day, Sydney Savory Buckman, born in 1860, early followed in his father's footsteps. His attention was particularly directed to the Brachiopoda and Ammonites of the Inferior Oolite, and so early as 1883 he contributed a paper on the former to the *Proceedings of the Dorsetshire Natural History Field Club*. Buckman will, however, be chiefly remembered for his work in connexion with the Ammonites, which he showed could be used as zone fossils for subdividing the Jurassic strata. His study of these was extensive, and a monograph of those from the "Inferior Oolite Series" (never really completed) formed one of the Monographs of the Palæontographical Society (1887–1907), while he further traced their evolution through the successive strata, and in so doing was led to create a multitude of genera and species far beyond what had hitherto been deemed necessary.

In connexion with all this work and subsidiary to it, Buckman published very many papers and memoirs on the classification of Ammonites and Brachiopods. When his connexion with the Palæontographical Society was severed, Buckman began in 1909 a work on "Yorkshire Type Ammonites," consisting of photographic figures of the types accompanied by the original descriptions. This was carried on until his eyesight failed six months ago. The geological structure of the Inferior Oolite also received his attention, and he traced foldings in the beds that in some cases corresponded with those known to exist in the underlying Palæozoic rocks, thus bearing out Godwin-Austen's principle of the continuity of folding with its economic consequences.

The physical geography of south-western England was the subject of a paper (*Natural Science*, 1899) far too little consulted by later writers, in which Buckman treated of the "Development of Rivers; and particularly the Genesis of the Severn." The capture of the headwaters of the Thames by the Severn has, perhaps, never been better set forth. Buckman's extensive and original work became absorbed to such an extent into contemporary geological thought that few of the younger generation of geologists realise how much they owe to him.

The value of Buckman's labours was recognised by the Geological Society, of which he was elected a fellow in 1882, by the award of the Murchison Fund in 1897, of the Lyell Fund in 1903, and the bestowal of the Lyell Medal in 1913. His researches stimulated many a geologist, and not in England alone, to a more detailed study of the rocks and their fossil contents, and all such he was ever ready to help in the most unselfish way. His death on Feb. 26 last was greatly regretted by all privileged to know him, and his memory will be cherished as one of the kindest of men.

DR. DU RICHE PRELLER.

DR. C. S. DU RICHE PRELLER died at his residence in Edinburgh on Feb. 17 in his eighty-fifth year. He was a notable representative of a type of which the numbers are steadily growing less, to the great loss of the community. A successful professional man, with varied interests rising naturally out of the practice of his profession, he superimposed upon those interests others which in the course of his long life led to his appearing to include most branches of knowledge within his sphere.

By training an engineer, Dr. Preller's technical training was supplemented by wide studies in pure science, carried out in French and German universities as well as in Yorkshire. His active career was spent mostly on the Continent, where he was engaged especially in railway and electrical undertakings in Germany, Italy, and Switzerland, being at one time chairman and chief engineer of the Limmat valley electric railway. He was also interested in the lighthouses of the French coast. From his absorption in hydro-electric installations there arose naturally an interest in problems of glacial geology and of mountain form and structure generally. Again, an inborn aptitude for languages —he belonged to a Huguenot family long settled in England—combined with long residence on the Continent, made him an excellent linguist; he spoke and read easily French, German, Italian, and Spanish. He had also a great love of music, art, and literature, while travel was another favourite recreation.

Though Dr. Preller collected together a number of studies on the geology of Italy in a book published in three volumes as "Italian Mountain Geology" (1918–23), for which the Royal University of Florence made him an honorary doctor of science, most of his scientific writings took the form of essays, papers, and letters contributed to technical, scientific, and other periodicals. He was an occasional contributor to NATURE, but many of the papers of his later years, after his settlement in Edinburgh in 1912, appeared in the *Scottish Geographical Magazine*. These dealt with a great variety of subjects, including the old problem of Hannibal's route across the Alps. With interests so widely diffused great originality was not to be expected, and accuracy in detail at times left something to be desired; but for these qualities we look to the specialists. The great importance of such men as Dr. Preller is that they act as liaison officers between the educated public and scientific specialists. Their steadily decreasing numbers is to be regretted in that the specialists are always tending to become more and more unintelligible even to their fellows in other branches.

WE regret to record the death of Dr. Humphrey Purnell Blackmore, widely known as an archæologist, which took place at Salisbury on Feb. 2, at the age of ninety-three years. He was educated at Queenwood College and qualified in medicine at the earliest possible age. While in practice at Salisbury he took up the study of geology. The results of his intimate study of local conditions were published in the Geological Survey account of Wiltshire. He contributed to the Blackmore Museum, which was founded by his brother, a valuable series of palæontological remains which he himself had discovered in the local gravels. When the Salisbury and South Wilts Museum was founded, now more than sixty years ago, it was very largely due to his activities, and he took a very considerable share in determining its methods and arrangement. His interests in archæology were wide, and brought him into intimate touch with the most prominent archæologists of his day, among the more noteworthy being Sir John Evans, Sir Augustus Franks, Lord Avebury, and Sir William Boyd Dawkins. Although to a later generation he was more widely known by name than personally, he was always ready to throw open the valuable collections in his house at Salisbury to research workers. With his death, and that of Sir William Boyd Dawkins, has finally passed away that generation of pioneers which founded British prehistoric archæology and raised it to the foremost place in the study of the culture of early man.

THE death is announced of Dr. Joseph Goldberger on Jan. 17. According to a *Daily Science News Bulletin* (Science Service, Washington, D.C.) he was born in Austria in 1874, and at the age of six emigrated with his parents to the United States. Twenty years later he joined the U.S. Public Health Service and soon afterwards was attached to the Hygienic Laboratory, Washington. His greatest contributions to science were his studies on the nature, cure, and prevention of pellagra, which he determined to be a food-deficiency disease dependent upon lack of fresh and proper proteins. He discovered that yeast is a preventive in the absence of fresh meat and milk. He also contributed studies on yellow fever, dengue, measles, and influenza.

WE regret to announce the following deaths:

Mr. Edward Davidson, for many years secretary and treasurer of the Royal English Arboricultural Society, on Mar. 4.

Dr. Alex Hill, secretary of the Universities Bureau of the British Empire and formerly Master of Downing College, Cambridge, and Principal of University College, Southampton, on Feb. 27, aged seventy-two years.

Mr. John Hyde, from 1897 until 1905 chief of the bureau of statistics of the U.S. Department of Agriculture, known also for his work on the economic effects of disease, food and population, etc., on Jan. 18, aged eighty years.

Dr. Frederic A. Lucas, director of the American Museum of Natural History from 1911 until 1923 and since honorary director, and a foreign member of the Zoological Society of London, on Jan. 9, aged seventy-six years.

Sir John Denison Denison-Pender, G.B.E., K.C.M.G., chairman of the Eastern and Associated Cable Companies, on Mar. 6, aged seventy-three years.

News and Views.

ON p. 415 of this issue we publish the first authoritative account to reach England of the skeleton discovered in January last in the Springbok Flats, Transvaal. The discovery has already been announced in cabled dispatches appearing in the English press, but the detailed account of the circumstances of its discovery and the results of the examination of the skeletal remains which Dr. Broom now gives make it possible to form a more adequate estimate of its importance. Its chief point of interest is that not only is the skull that of modern man, but it bears a close resemblance to the Cro-Magnon type of the European upper palæolithic age. In this it agrees with the Boskop skull; but another feature which it has in common with that skull and in which they both differ from the Cro-Magnon is, that while the latter is high, they are both low. This is important, as by some the Boskop skull was thought to have suffered from post-mortem deformation. The long bones of the new skeleton, though much broken, by the estimate of their length would bear out the resemblance to Cro-Magnon man in point of being large. The Bushveld skull, as Dr. Broom suggests the new find should be called, resembles the Boskop skull in that the eyebrow ridges are not prominent and both are large-brained. Although not so long as the Boskop skull, to which an estimated length of 210 mm. was given, the Bushveld skull measures 195 mm. This, on an estimated breadth of about 144 mm., gives a cephalic index of 74. Although, as Dr. Broom points out, the new skull differs from the Boskop skull in several particulars, it confirms the evidence of the earlier find of the existence in South Africa of an early large-brained race. But, whereas the Boskop skull was regarded as showing affinities with no existing race in South Africa, Dr. Broom is inclined to see in the Korannas the descendants of Bushveld man.

THE suggested correlation of the Bushveld man with the middle palæolithic of South Africa, through the association of the remains with an extinct species of buffalo also found in association with the Hagenstad type of stone implement, adds considerably to the interest and importance of the find. This may be still further enhanced when it is possible to bring it more closely into relation with the investigations which Mr. Leakey is carrying out in Kenya, where it is evident from the communication which appeared in the *Times* on Mar. 7 that finds of a crucial character are possible at any moment. The discoveries of this season which Mr. Leakey announces are of a sufficiently surprising nature. In last season's excavations at Elmenteita a Mousterian layer had been reached below the Aurignacian level in the cave known as Gamble's Cave II. This year, two occupation levels with industries of typical Aurignacian facies have been found below the Mousterian horizon, belonging to the same Second Pluvial period as that horizon. This sequence has been confirmed at a number of sites. As there is no evidence of any mingling of the Mousterian and Aurignacian industries, it can only be concluded that the Mousterian in East Africa represents an actual racial intrusion and not merely a cultural influence, while, further, the reversal of the sequence normal in Europe points to the immigration of a race from outside into an area in which the Aurignacian was either the indigenous culture or, at any rate, in which it was sufficiently near its place of origin to permit of its earlier penetration. This is what might be expected on the view of the African origin of the Aurignacian culture. Two skeletons have been discovered which agree with previous discoveries in associating *Homo sapiens* with Aurignacian industries. Mr. Leakey, holding that any human remains discovered in association with the Mousterian industry will be of the Neanderthal type, suggests that such remains may link up man in East Africa with Rhodesian man.

THE centenary of King's College directs attention to an educational institution which has the distinction of being one of London's oldest colleges and the misfortune of being one of the poorest. It is the worst-endowed College in Great Britain, and yet the numbers of students have doubled since the War, and the high standard both of its teaching and research is being steadily maintained. While the appeal for £350,000 which has been launched is wide, in that it embraces the improvement of buildings, the provision of endowments, scholarships, and bursaries, there is one particular aspect which we would recommend to our readers. The College has always occupied a leading place in its work for scientific progress. It was the first English college to establish either a physics or a bacteriological laboratory. The work done in the physics and electrical departments is particularly distinctive. Wheatstone invented the telegraph; Maxwell disclosed the principle to which broadcasting owes its origin; while in more recent times Prof. O. W. Richardson formulated the laws underlying the action of wireless valve filaments. Important wireless research is at present being pursued by Prof. E. V. Appleton.

THE electrical industry is largely indebted to work carried on at King's College. The theory of the parallel running of electrical alternators as used to-day in all the large power stations, and the invention of the three-wire system of supply, were first propounded by Prof. John Hopkinson. The present professor of electrical engineering, Prof. Ernest Wilson, has carried out important investigations on the corrosion of metals such as are used for overhead wires and are exposed to the London atmosphere. Neither the physics nor the electrical engineering departments has an endowment income. They are almost entirely dependent upon a fluctuating student fee income. It is now proposed to raise a sum of £50,000 to endow chairs in these two departments. The amount is modest enough in comparison with the wealth of the wireless and electrical industries, and donations to either branch of the College would be a recognition of indebtedness and an encouragement for future

research. Donations may be sent either direct to King's College, Strand, W.C.2, or to the College bankers, Messrs. Coutts and Co., 440 Strand, W.C.2.

AT the South Africa meeting of the British Association in July next, the Council will nominate Dr. F. O. Bower, F.R.S., lately Regius professor of botany in the University of Glasgow, as president of the Association for the year 1930, when the meeting will be held in Bristol. The Association has received from the Court of Common Council (the Corporation of the City of London) the expression of a hope that London will be selected as the place of meeting in the centenary year, 1931, and offering entertainment to the Association in that event. This invitation has been accepted, and the centenary meeting will therefore be the first ever held in London.

IN view of the importance of the wool industry to South Africa, it is fitting that wool research should be a strong feature at the meetings of the British Association this year. Among those who have already signified their intention of being present are Prof. Aldred F. Barker, head of the Textile Department of the University of Leeds; Dr. S. G. Barker, Director of Research of the British Research Association for the Woollen and Worsted Industries, and Dr. J. E. Nichols, also of the Research Association, who is at present engaged on a sheep and wool survey of the British Empire. Principal H. Richardson, head of the Technical College, Bradford, is also expected to attend. Dr. J. E. Duerden, Director of Wool Research of the Union of South Africa, will give an account of the wool investigations in progress in the South African Department of Agriculture, and others will deal with various nutritional and genetical experiments. Mr. E. N. S. Warren, head of the Sheep and Wool Section at the Grootfontein School of Agriculture, will describe the instructional course given there, which is admitted to be one of the foremost in the world.

THE inauguration of a television broadcasting service in Great Britain is at present being considered by the Post Office officials. Great progress has recently been made at the Baird laboratories and very satisfactory demonstrations of land line transmissions have been given on a 'televisor.' It is quite easy to 'tune in' the picture by one control and 'frame' it correctly by the other control. The pictures are still somewhat limited in size, but excellent 'head and shoulders' reproductions are given, and in conjunction with a loud speaker give a very interesting performance. Considerable detail is given in the picture—the time, for example, on the performer's watch can be easily read. A high tension pressure of 350 volts is required for the home televisor, but if an alternating current lighting supply is available, this can be readily obtained by an 'eliminator.' At present the sets are designed for a fixed wave-length of 200 metres (1500 kilocycles). It is, perhaps, too early to say what is the narrowest band of frequencies that is necessary to transmit a sufficiently satisfactory picture. In the event of the establishment of a television broadcasting service, it would be advisable to have as narrow a band as possible so as to avoid interference with the ordinary broadcasting and other services. Everything depends on how much flicker and lack of detail can be permitted without appreciably detracting from the pleasure of the 'looker-on.' Television for the theatre seems to be an easier problem than television for the home. As this would be worked throughout by experts, the large performance factor of safety required for home sets would be unnecessary.

IN every continental area the number of wave-lengths available for broadcasting is strictly limited. The radiation from an aerial may be considered as made up of rays parallel to the surface of the earth and of rays inclined to the surface. The latter radiations suffer very little attenuation, and, striking the conducting layer, get bent down towards the earth and sometimes produce interference with parallel waves. Such interference has been noticed between stations 2000 miles apart. In a paper by P. P. Eckersley and A. B. Howe, read to the Institution of Electrical Engineers on Mar. 6, a method of getting over interference difficulties by using the same wave-length for several stations is discussed. Three other methods have been suggested. The first is by securing a proper international agreement between the nations, the second by designing all transmitting aerials so that only radiations parallel to the earth's surface are emitted, and the third by using only a few high-powered stations instead of many low-power stations. Most broadcasting authorities throughout the world are adopting the third of these methods. In 1924, Captain Eckersley suggested in addition that several broadcasting stations in each country might be operated on the same wave-length. At the present time Edinburgh, Hull, Bradford, and Bournemouth share the same wave-length with satisfactory results. The case of Bradford is interesting, as it is only about 60 miles from Hull. When Bradford shared a wave-length with other European stations the good service range was only about half a mile from the aerial. Now, although it has the same wave-length as Hull, it has a good service range exceeding five miles. The chief sphere of usefulness of this new method is to bring first-class service to isolated towns. Low-powered stations and short wave-lengths would be used, as all the regional high-power stations need long wave-lengths. The method should appreciably relieve the broadcasting conditions in Europe.

THE Institute of Metals, founded for the study of Non-Ferrous Metallurgy in 1908, which has just held its twenty-first annual meeting, had an initial membership of about 250. To-day the roll of its members exceeds 2000, of whom about two-thirds are British and Empire members, while the remaining one-third consists of foreign members. At the time of its formation many doubts were expressed whether such an institute could be formed and maintained, and whether it would fulfil any really useful function. When the successful career of the Iron and Steel Institute was cited as an encouraging example, the doubters pointed out that the non-ferrous industries were much smaller, less wealthy, and less advanced

from a technical and scientific point of view. It was even feared that manufacturers might not wish to support such an institute and that they would decline to allow the members of their staffs to take part in its meetings for fear of divulging confidential information. Fortunately, the small band of enthusiastic founders of the Institute did not permit themselves to be deterred by such misgivings, and as soon as a start had been made it became abundantly clear that a real need existed for an institute dealing with the non-ferrous metals. From the very beginning the Institute prospered. Its membership began to grow steadily and still continues to increase to-day, while the value of its work and influence stands fully recognised both in Great Britain and abroad. Its first three presidents were the late Sir William White, the late Sir Gerrard Muntz, and the late Prof. W. Gowland, representing respectively the user, the manufacturer, and the scientific student of metals. This order of rotation in filling the presidential chair has been followed, with a few exceptions in special circumstances, throughout the past history of the Institute. It is intended to emphasise the fact that the Institute seeks to serve the interests of all those directly concerned with the non-ferrous metals, whether as users, manufacturers, or scientific investigators and teachers of metallurgy.

A PROVISIONAL notice of the forthcoming International Congress of Forestry Experimental Stations, to be held at Stockholm and elsewhere next July, has already appeared in NATURE (Dec. 1, 1928, p. 852). The sessions of the Congress will take place in Stockholm during the week July 22–27, an excursion being paid during the week to visit forests at Noorköping and Katrineholm. Although the deliberations of the Congress are confined to a week, the programme laid down is more comprehensive. Two extensive tours, one in the south and the other in central and north central Sweden, are projected, each covering eight days, during which a considerable part of the country will be traversed. Those members wishing to participate in the first tour will assemble at Malmö on July 14, arriving at Stockholm on July 20. During this period interesting forests will be visited at Dalby, Furen, Bokenäs, Malingsbo, Siljansfors, and in the region of Siljan and Domnarvet. A number of private forests (pine, spruce, and beech) will be visited on this southern tour. Also the pine and spruce State forests of Malingsbo in Dalarna, where the College of Forestry has instructional forests; and the experimental forests of Siljansfors, which are under the management of the Experimental Station and in which research work is undertaken. This excursion will conclude with a trip through the beautiful country round Lake Siljan, when the rafting in the Dalälven River will be seen and a visit paid to the town of Falun, an ancient ore-mining and forest industries centre.

THE second excursion which has been arranged for the International Congress of Forestry Experimental Stations will prove of even higher interest. Members will leave Stockholm for Bispgården on July 28 and will visit forests and forest industrial works at Kulbäcksliden, Svartberget, Lycksele, Hoting, Frösën to Åre, situated in the highlands of Jämtland, where amongst other things of interest the wonderful waterfall of Tännforsen will be viewed. The intention of the northern tour is to demonstrate the forestry problems of Norrland and the difficulties incurred in slow-growing northern forests with a more or less sterile soil. Rafting and the industrial side of forest work in Sweden, which is of such great importance to the commercial well-being of the country, will be seen. The programme laid down for this Congress is extensive and can scarcely fail to be productive of work of importance to forestry science, whilst the members will have an opportunity of becoming acquainted with some valuable aspects of Swedish forestry methods.

THE following were elected fellows of the Royal Society of Edinburgh at a meeting held on Mar. 4: Dr. S. G. Barker, director of research, British Research Association for the Woollen and Worsted Industries, Leeds; Dr. F. Bath, lecturer in mathematics, University of St. Andrews; Mr. G. Bennet, lecturer in mechanical engineering, Heriot-Watt College, Edinburgh; Dr. A. Calder, assistant in the Animal Breeding Research Department, University, Edinburgh; Dr. G. Coull, pharmaceutical chemist, of Leith; Prof. E. W. H. Cruickshank, Physiology Department, Dalhousie University, Halifax, Nova Scotia; Mr. D. Kennedy Fraser, psychologist to the Education Authority, Glasgow; Mr. T. Henderson, actuary of the Savings Bank of Glasgow; Dr. Sunder Lal Hora, senior assistant superintendent, Zoological Survey of India, Calcutta; Prof. J. Kendall, Chemistry Department, University of Edinburgh; Mr. J. R. Little, general manager and secretary of the Century Insurance Co., Edinburgh; Prof. D. N. M'Arthur, Department of Agricultural Chemistry, West of Scotland Agricultural College, Glasgow; Mr. J. Mackie, mathematical master, Leith Academy, Leith; Mr. W. Mercer, lecturer in clinical surgery, University of Edinburgh; Mr. H. Moir, president, United States Life Insurance Co., in the City of New York; Prof. F. W. Ogilvie, Department of Political Economy, University of Edinburgh; Dr. J. F. V. Phillips, botanist, Tanganyika Territory; Mr. S. Read, Edinburgh Academy; Mr. R. A. Robb, lecturer in mathematics, University of Glasgow; Principal J. C. Smail, Heriot-Watt College, Edinburgh; Prof. Sydney Smith, Department of Forensic Medicine, University of Edinburgh; Dr. T. Southwell, lecturer in helminthology, School of Tropical Medicine, Liverpool; Mr. A. C. Stephen, assistant, Natural History Department, Royal Scottish Museum, Edinburgh; Dr. B. P. Wiesner, lecturer in sex physiology, University of Edinburgh.

THE United States Bureau of Mines has issued its report upon coal production in 1926. It consists, as usual, of numerous detailed statistical tables, whilst there is also much interesting information explaining the changes from year to year in the statistics quoted. The greater part of the report is interesting only to coal workers in the United States, but there are some passages which coal producers, and especially coal miners in Great Britain, would do well to take to

heart. Thus the report states that "The foreign demand was unusually intense because of the seven months' suspension of production in Great Britain. The general walkout of the British miners on May 1 immediately started discussion of exports from this country." "A gain of approximately 14,000,000 net tons of shipment to Europe represented the greater part of the growth in the sea-borne trade in 1926. This coal displaced former British tonnage in the main and went chiefly to the United Kingdom, Irish Free State, Italy, and France."

ENGINEERS engaged in designing will be interested to know that Messrs. Adam Hilger, Ltd., are now making Prof. Coker's well-known apparatus for the study of the stresses in engineering structures by means of the double refraction which stresses produce in transparent models, and the effect this double refraction has on either plane or circularly polarised light passing through them. Models of celluloid, stressed in their own planes, are used up to 3 inches long. In circularly polarised light the areas of maximum stress are immediately apparent, and for many purposes this will be sufficient for the engineer. If the actual magnitudes and directions of the principal stresses at each point are required, a more detailed examination under plane polarised light and with an auxiliary sheet of the same celluloid in simple tension used as a standard of stress is necessary.

IT has well been said that the aspiration after the understanding of human nature and human actions is the key to much that is characteristic of the present century. It is beginning to be realised that science is the new humanism, and that industrial aspects of it have to be considered not merely as profitable enterprises but also in relation to social welfare. We therefore welcome the announcement of the publication of a new monthly magazine — *The Realist* — which will aim at presenting contacts of scientific discovery and other forms of creative expression with social, economic, and political affairs of the modern world. The magazine has a strong editorial board representative of many fields of progressive thought and action, and it should make a wide appeal to intelligent citizens who seek something more substantial than they usually find in journals devoted to literary and political trivialities. The first number is to appear on Mar. 26, and will be issued by Messrs. Macmillan and Co., Ltd., for the Realist Publishing Co., 25 Victoria Street, S.W.1.

THE Torquay Natural History Society shows satisfactory progress. In spite of the fact that the building of an extension to the Museum interfered with the ordinary course of museum work, a varied programme of twenty-two lectures was carried through. The addition of a second storey to the museum has permitted the exhibition of a loan collection of ethnographical specimens and of much material formerly stored away. The activities of the Society are carried on by a series of sections with specialised interests, the most lively being the archæological, the botanical, and the entomological. In each of these, papers of general and local interest were read, and some of these have been published in the *Transactions*.

THE Report of the Museums of the Brooklyn Institute of Arts and Sciences for 1927 gives a great impression of activity and progress, not only in the field of exhibition pure and simple, but also in many side activities aiming at the education of the student and the people in general. The Department of Natural History has been given much additional room for expansion, many new galleries, three of which have been converted into European period rooms, have been opened, a large annex has been adapted for the Children's Museum at a cost of some £10,000, and a lunch and tea room has been created. The energy of the staff is indicated by the fact that ten special exhibitions of various art collections and eight exhibitions of prints were held in the course of the year. Special educational activities include the institution of a press for printing lithographs for the use of students, the formation of a class in clay modelling for children in the elementary schools, the exhibition of motion picture films portraying the "Chronicles of America," and zoological subjects (purchased from Raymond L. Ditmars) for school children, as well as lecture courses for the public, for teachers, and for students. The Children's Museum, with its loan exhibits of natural history specimens, its school visits helped by three teachers assigned by the education authorities, its summer field trips, and many other activities, ought to instil the scientific mood at a period when it is most likely to have a telling influence. The cost of running these excellent museums during the year was roughly £43,000 for the Central Museum, and £4700 for the Children's Museum.

THE G. J. Symons Memorial Lecture of the Royal Meteorological Society will be delivered on Mar. 20, at 7.30 P.M., by Mr. R. A. Watson Watt, who will take as his subject "Weather and Wireless."

DR. L. F. HEWITT has been appointed bio-chemist at the Metropolitan Asylums Board's antitoxin establishment, Belmont Laboratories, Sutton, Surrey. Dr. Hewitt is at present Gibbons Research Fellow at the London Hospital; and was formerly research chemist, Medical Research Council, Mount Vernon, Hampstead.

A VIOLENT earthquake was recorded at Kew Observatory on Mar. 7. The first tremors reached the observatory at 1 hr. 46 min. 36 sec. G.M.T. The distance of the epicentre is estimated at 5400 miles, and the bearing is 7° W. of N., corresponding with a position near the Aleutian Islands, lat. 50° N., long. 168° W.

AN additional evening meeting of the Royal Geographical Society will be held on Monday, Mar. 25, at 8.30 P.M., at the Polytechnic Theatre, Regent Street, when Sir Douglas Mawson will give an account of recent work on the fjords of New Zealand and will show the kinematograph film of his Antarctic Expedition of 1911–1914, not before shown in England in its final form.

MAJOR H. O. D. SEGRAVE established a new speed record on Mar. 11 at Daytona Beach, Florida, with an average of 231·36226 miles an hour. Major Segrave was driving his Irving Special racing car *Golden Arrow*,

and covered the mile course in each direction at just over 231 miles an hour. The *Golden Arrow* has a 12 cylinder Napier-Lion engine which develops 930 h.p. and is not supercharged; the body of the car consists of three stream-line forms. The previous highest speed, 207·55 miles an hour, was attained by Mr. Ray Keech driving Mr. J. M. White's Triplex car on April 22, 1928.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—An assistant veterinary inspector under the Surrey County Council—The Clerk of the County Council, County Hall, Kingston-upon-Thames (Mar. 20). A lecturer in electrical engineering at the Rugby College of Technology and Arts—The Organiser of Further Education in Rugby, 61 Clifton Road, Rugby (Mar. 20). A head of the Mathematics Department and organising assistant to the Principal of Leeds Technical College—The Director of Education, Education Department, Calverley Street, Leeds (Mar. 23). An assistant lecturer in botany in the University of Bristol—The Secretary, The University, Bristol (Mar. 25). A deputy curator of the Sunderland Public Libraries, Museum, and Art Gallery—The Chairman of the Libraries, Museum, and Art Gallery Committee, Town Hall, Sunderland (Mar. 25). A lecturer in physics at the Chelsea Polytechnic—The Principal, Chelsea Polytechnic, Manresa Road, S.W.3 (Mar. 28). A demonstrator for laboratory work in physics and electrical engineering at the Royal Naval Engineering College, Keyham (Plymouth)—The Secretary of the Admiralty (C.E. Branch), Whitehall, S.W.1 (Mar. 31). A head of the pharmacy department of the Leicester College of Technology—The Registrar, College of Technology, Leicester (April 3). A lecturer in the Department of Mining of the Imperial College of Science and Technology—Prof. S. J. Truscott, Imperial College of Science and Technology—Royal School of Mines, South Kensington, S.W.7 (April 15). A professor of biochemistry in the University of Alberta—The Secretary of the Board of Governors, University of Alberta, Edmonton, Alberta, Canada (May 14). A junior chemical assistant to the Research Association of British Flour Millers—The Director of Research of the Association, Old London Road, St. Albans. A senior science mistress at the County School for Girls, Beckenham—The Head Mistress, County School for Girls, Beckenham. A bacteriologist in the Malayan Medical Service—The Private Secretary (Appointments), Colonial Office, 2 Richmond Terrace, S.W.1.

Our Astronomical Column.

TWO NAKED-EYE SUNSPOTS.—Two groups of sunspots, large enough to be seen with the naked eye, have recently been on the sun's disc at the same time. The larger of these was a stream, with a big composite leader spot, crossing the central meridian on Mar. 11. It was the return or revival of a group in the previous rotation with central meridian passage on Feb. 12.

The second group consisted of a single spot, fairly regular in outline, and showing bright projections partly across the umbra; there were small companion spots and a subsidiary stream southwards. The following table gives other details of the two groups :

No.	Date on Disc.	Central Meridian Passage.	Latitude.	Area.
3	Mar. 2–14	Mar. 8·3	7° S.	1/2000
4	Mar. 5–17	Mar. 11·0	10° S.	1/800

(Areas express proportion of hemisphere covered.)

CHANGES IN THE EARTH'S ROTATION.—A paper by the Astronomer Royal and Mr. R. T. Cullen was read at the meeting of the Royal Astronomical Society on Mar. 8, in which the residuals in longitude of the sun for the last 150 years were compared with those for the moon. It was found that a much greater accordance was produced by deducing the sun's longitude from the observed Declinations in the neighbourhood of each equinox, than by deducing it from the Right Ascensions. The early observations of Right Ascension of the sun are affected by abnormal errors which do not enter into the Declinations to the same extent.

The new reduction leads to a much closer resemblance between the curves of solar and lunar residuals than has previously been obtained, and thus strengthens the hypothesis that the cause of these fluctuations lies in the earth's rotation, not in the bodies themselves.

MEASUREMENT OF STELLAR RADIATION.—The recent considerable advances made by Pettit and Nicholson in the knowledge of stellar radiation has been made possible largely through the great 100-inch Hooker telescope, combined with the extremely delicate thermocouples and refined methods of measurement introduced by these two pioneers. Their latest results are given in the *Astrophysical Journal*, vol. 68, p. 279, which includes an interesting account of the construction of the thermocouple. This delicate operation, in which wires of about 0·03 mm. are used, has to be performed under a microscope, and the resulting thermocouples are capable of measuring radiometric magnitudes with an uncertainty of only 0·1 of a magnitude. A discussion of the observing methods used and the reduction of the observations is followed by the results obtained for the 124 stars so far observed. These are reduced to a homogeneous system of radiometric magnitudes, heat indices, and water-cell absorptions, corresponding to the standard conditions of (1) the star in zenith, (2) two reflections from fresh silver, and (3) a rock-salt window in thermocouple. The corrections required to reduce to no atmosphere and for the total radiation reaching our system are given, as well as the computed bolometric magnitudes.

DETONATING FIREBALL IN NEW ZEALAND.—There has been evidence of a widely awakened interest in astronomy of late years in New Zealand. One of the directions of its manifestation is the careful observation and discussion of meteors. Mr. R. A. McIntosh describes in *B.A.A.J.* for February a brilliant fireball that appeared over the Coromandel Peninsula (North Island) on the night of Oct. 27, 1928. As the moon was full, and yet the object was so conspicuous, the magnitude is estimated as −15; the explosion was seen by three observers; the meteor separated into three or four portions, which quickly died out. The height at commencement was 75 miles, at the end 25 miles, the visible track being 107 miles long and the velocity 27 miles per second. The explosion shook the houses, and was heard over a large area. A faint trail was seen for 2½ seconds. The radiant was at 6° + 24°, near Alpha Andromedæ.

Research Items.

CLIMATE AND HEALTH.—The statistical relations between climatic factors and human health has been investigated by Dr. A. Wallen in a publication of the *Statens Meteorologisk-Hydrografiska Anstalt*, Bd. 5, No. 1, of Stockholm, entitled "Vädevlekens Samband med Hälsotillståndet." Dr. Wallen has studied the correlations between the mortality and health of Stockholm and Göteborg on one hand, and pressure, temperature, humidity, precipitation, and diurnal variation on the other. No particular relationship is found between pressure and health, but mortality increases during high pressure both in summer and winter. This, however, may be due rather to the associated high temperature in summer and low temperature in winter. A close relation appears to occur between temperature and health. Humidity also plays an important rôle. Dry seasons at all times of the year show an increase in the mortality rate, and winters and springs with a high humidity are also marked by a high mortality. No relation was traceable between the amount of precipitation and health or mortality. Considerable diurnal variations in temperature or in pressure show correlations with an increase in the mortality rate. Dr. Wallen also traces correlations between meteorological factors and the number of workmen on sick leave in a large factory with 1000 employees. A close correlation was shown in an increased number of cases during low barometric pressure. The paper contains a large number of graphs and statistical tables, and a useful bibliography of the subject.

HANDWRITING.—*Science Progress* for January has an article on experimental graphology by R. Saudek. Handwriting being a very personal activity, one would expect on *a priori* grounds that it would be possible to deduce from it something of the personality of the writer. Numerous attempts have certainly been made and while some people would seem to have had some success in individual cases, yet the scientific treatment of the subject is very recent. From the legal point of view the aim of the graphologist is to discover whether the questioned document is the work of the reputed writer, and, if it is not, to prove the identity of the handwriting in its inconspicuous characters with that of the suspected person. The assumption on which the expert relies is that the inconspicuous features of the handwriting cannot be consistently disguised in a manuscript of any length. The problem of the diagnosis of the character of the writer is more complicated. The writer of this article has subjected handwriting to a detailed analysis, and asserts that there are at least twelve factors that co-operate in the formation of the individual writing. These factors include the writing instruments, the degree of maturity of the writer, the acute physiological condition of the writer, and the speed of the act of writing, etc. Detailed explanations are given and specimens of handwriting illustrating the various points. The kinematograph has proved useful in distinguishing some of the laws. The research is interesting as marking a beginning of the study of this subject, though one is left with the feeling that much yet remains to be done.

WILD BIRDS AND DISEASE IN THE POULTRY YARD.—Various investigators have shown that a number of species of wild birds occasionally harbour a gape-worm identical with that which causes severe epidemics amongst poultry (*Syngamus trachea*). Odd records refer to the pheasant, thrush, magpie, jay, and jackdaw. A more serious infestation may occur in the starling, in which Lewis found that, in the Aberystwyth district, 169 out of 482 (35 per cent) carried the parasite. Charles Elton and Frank Buckland have now discovered that a much higher percentage of the rooks in the Oxford district are similarly affected (*Parasitology*, vol. 20, December 1928). The samples are small, but the results are striking: of eight adults examined, four contained gape-worms, and 31 out of 33 young rooks. Rooks and starlings are frequent visitors to the poultry yard, and the possibility that they may be responsible for the distribution of gape-worms amongst domestic fowls deserves immediate investigation. The very high incidence of the presence of gape-worms amongst young rooks may account in part for the mortality which they are known to suffer in the nest, and this also may be a factor of some economic importance.

PARASITIC WORMS OF THE WILLOW GROUSE.—A paper by Johan Huus (*Bergens Mus. Aarbog*, 1928) forms one of the contributions to the extensive investigation recently completed on the biology of the willow grouse in Norway. The alimentary tracts of 517 birds were examined and four species of worms obtained, namely, two nematodes—*Ascaridia compar*, *Capillaria longicollis*, and two cestodes—*Railletina urogalli* and *Weinlandia microps*. *Ascaridia compar* was found in the jejunum of 190 of the birds examined. A careful account is given of the morphology, the distribution and the biology of the worm. The larvæ of *Ascaris lumbricoides* and of *Ascaridia galli* are known to pass from the intestine into the blood stream and via the heart to the lungs, where they escape into the alveoli, and thence come into the trachea and pharynx, from which they pass into the stomach and intestine. The author believes that the larvæ of *Ascaridia compar* have a similar course, for the youngest examples found in the duodenum were 3 mm. long and were undergoing their last ecdysis. There is no evidence that this worm is pathogenic; the passage of the larvæ through the lungs, especially in young chicks, may be harmful. *Capillaria longicollis* was found only in three birds, in the duodenum. *Railletina urogalli* was present in the jejunum of 57 of the birds examined, and *Weinlandia microps* in the duodenum in 60 cases. The author points out that parasitic worms were not present in the cæcum of the birds examined.

RESEARCHES ON COPEPODS.—Mr. A. G. Lowndes, of Marlborough College, in continuation of his researches on freshwater copepods, has published two interesting papers, "Freshwater Copepoda from the New Hebrides" (*Annals and Magazine of Natural History*, Ser. 10, vol. 1, June 1928) and "The Result of Breeding Experiments and other Observations on *Cyclops vernalis* Fischer and *Cyclops robustus* G. O. Sars" (*Internat. Revue der ges. Hydrobiol. u. Hydrographie*, Bd. 21, Heft 3/4, 1928). The first of these deals with a collection of copepods made by Dr. J. R. Baker from a large lake on the Island of Gaua. The lake is more than 300 feet deep, the *p*H at the surface and middle layers was 8·5 and the temperature 25° C. Five species of copepods only were obtained, all but one well known and of wide distribution. It is very interesting to find that in the majority of cases little or no difference in structure is visible between the forms from the New Hebrides and those from the British Isles and elsewhere. No Calanoids were found in this collection. In a sample from Hog Harbour, Santo, *Cryptocyclops anninæ* occurred in abundance in empty coco-nut shells. In the second paper Mr. Lowndes describes the result of breeding together the two copepods *Cyclops vernalis* and *Cyclops robustus*, the object of the work being to decide whether *C. robustus*

should be regarded as a separate species or only as a variety of *C. vernalis*. The specific characters are based almost entirely on the spine formulæ and on the nature of the setæ. Mr. Lowndes has shown in previous breeding experiments on *Cyclops* that the spine formulæ may be exceedingly variable and too much importance must not be attached to these for the identification of species. The experiments were carefully carried out, and in addition cultures were made from the adult female of *C. robustus* which gave rise to *C. vernalis*. *C. vernalis* was successfully crossed with *C. robustus*. Both forms occur together in the same pond with every gradation between the two. It is concluded from these observations that *Cyclops robustus* is not a separate species, but only a form of *Cyclops vernalis*.

FISHES FROM FLORIDA AND THE WEST INDIES.—In the paper under this title (*Proceedings of the Academy of Natural Science of Philadelphia*, vol. 80; 1928), Mr. Henry W. Fowler reports on collections obtained in Florida, the Bahamas, Haiti, Porto Rico, Saint Lucia, and Dominica. The specimens, except the Porto Rican collection, are in the Academy of Natural Science of Philadelphia. Several hundred species are recorded, but none is new, although there are new localities for many of the fishes and some are specially interesting in their distribution. The author also mentions nineteen examples of *Rivulus hartii* (Boulenger) from Pitch Lake, in Trinidad, British West Indies, which were presented to the Academy by Dr. Judson Daland in April 1928. Some of the species from Florida are new to the United States fauna. These include a specimen of *Rivulus cylindraceus* Poey which is re-described. There are some rare fishes from the Bahamas. One specimen of *Sparisome radians*, 81 mm. long, was taken from the stomach of *Serranus striatus*. From Bermuda three examples of *Halichœres radiatus* are recorded and one of *Callyodon plumbeus*. A collection of 69 species come from Haiti, obtained by Mrs. James Bond in the Porto Prince market. Valuable colour notes are given for many of the fishes.

THE BLOOD OF INVERTEBRATES.—The holothurian *Caudina* is a favourite subject for physiological research, and is specially interesting, for not only is there hæmoglobin in its blood, but also this is contained in corpuscles, as Hogben recently described in a South African *Cucumaria*. Two papers in the *Science Reports of the Tôhoku Imperial University* (4th series (Biology), Sendai, Japan; vol. 3, No. 4, Fasc. 1; 1928) deal with the subject. In "Chemical Studies on Sex Differences of Blood Protein in *Caudina chilensis* J. Müller," Tetssutaro Tadokora and Shukichi Watonabe have followed up their researches on sex differences in the blood protein of mammals. They contend that similar differences are found in *Caudina*. Mr. Nobukuki Kawamoto ("Oxygen Capacity of the Blood of Certain Invertebrates which contain Hæmoglobin") uses the mollusc *Andara inflata* as well as *Caudina* for his experiments. Both contain hæmoglobin in the blood corpuscles, and the present work was undertaken in order to make a comparison with the blood of invertebrates having no hæmoglobin, such as those used recently by other workers (*Helix*, *Octopus*, *Homarus*, *Astacus*, *Cancer*). It is shown that compared with the higher Mammalia, the blood of *Andara* and *Caudina* absorb much less oxygen, but compared with the invertebrates quoted, the oxygen capacity is much greater. It is also greater that that of sea water.

EARLY HISTORY OF COTTON.—A. N. Gulati and A. J. Turner, of the Technological Laboratory of the Indian Central Cotton Committee, have an interesting note on the early history of cotton in *Bulletin* No. 17, Technological Series No 12, issued in October 1928 by this Committee. (The same paper appears in the *Journal of the Textile Institute*, **20**, pp. T1-T9, January 1929.) The earliest known mummy cloths in Egypt, according to Petrie, date from about 5500 B.C. and are made of flax. No Egyptian mummy cloths appear to have been made of cotton, but mummy cloths of cotton have been found in Peru, where one species of *Gossypium* seems to be indigenous. Recently, scraps of cotton material have been found amongst the remains of the prehistoric civilisation unearthed at Mohenjo-daro in Sind. These remains belong to the three latest cities erected on this site, which are ascribed to dates between 3500 B.C. and 2400 B.C. Messrs. Gulati and Turner have made as full an examination of this material as the condition of its preservation permits, and conclude that the cotton is not of the *G. herbaceum* type, but more closely related to the coarser fibres of the *G. arboreum* type. One sample of string found in earthenware had a purple colour; a few tests made on this sample suggested that the dyestuff originally employed was of the madder type.

ABACÁ, A LITTLE-KNOWN PHILIPPINE FIBRE.—The Cordage Institute of the United States has made possible a detailed study of the conditions of cultivation and production of 'abacá' fibre. This product is obtained from the outer, lower side of the long fleshy leaf stalks of *Musa textilis* Née, which overlap to form the main stem of this plant. The industry is indigenous to the Philippines, where the fibre has been known since Pigafettas' diary of Magellan's trip around the world (1519), in which the name first appears. A million or more bales of fibre from cultivated varieties of this plant are annually exported from the Philippines, whilst fibre is now also being produced from the same plant in Borneo, Java, and Sumatra. During recent years a scientific study of the crop and its product has been initiated, and the *Philippine Journal of Science*, Vol. 37, No. 1, Sept. 1928, contains a series of papers by P. L. Sherman, Cordage Institute Fellow, and his colleagues of the Bureau of Science, Manila, which give the first results of this work. These papers deal largely with the soil conditions and the state of the fibre as originally prepared. Active fermentation processes are at work in the soil owing to the mass of rotted vegetable material from the leaf debris left after cutting out the fibres; partly as a result, the extracted fibre is usually somewhat full of acid materials, and the writers point out that unless it is thoroughly dried before it leaves the collecting ground, there is great danger of rapid deterioration in storage.

FOSSIL OSTRACODA OF ITALY.—A monograph on the fossil Ostracoda of Italy has been begun by A. Neviani. The first part (*Mem. Pont. Accad. Sci. N. Lincei*, Ser. 2, vol. 2) treats of those from the classical beds of Vallebiaja, near Fauglia, which the author refers to the Lower Calabrian of Gignoux. Nearly 70 species are described, about 18 being considered new, and the details of their occurrences in time from the Mesozoic to the present day are set forth in tabular form. There is a good index and two excellent plates.

THE BUSHVELD COMPLEX OF THE TRANSVAAL.—Among the spectacular geological phenomena for which South Africa is becoming increasingly famous, the great body of igneous rocks known as the Bushveld complex occupies an impressive position. Molengraaf, Mellor, Hall, Wagner, du Toit, and other pioneers have already established its principal

features, and now a valuable summary appears from the able pen of Prof. R. A. Daly, accompanied by eighteen new analyses and a stimulating discussion of the kind which enlivens all his contributions to geological literature (*Bull. Geol. Soc. America*, vol. 39, pp. 703-768; 1928). This paper should be of special value to geologists attending the South Africa meeting of the British Association and the meeting of the International Geological Congress. Some of Daly's conclusions differ from the current interpretation of the Union Geological Survey. According to the latter, the Bushveld felsite is excluded from the complex and assigned to a Rooiberg series which is made the top of the Transvaal system. Daly thinks that the felsite is at least partly, and possibly wholly, a definite member of the complex, akin to the roof of the Duluth 'lopolith' which seems to have been in part its own extrusive phase, chilled against the atmosphere. It is also suggested that the coarse granites of the Complex are not contemporaneous throughout, but are made up of two main intrusions; one red, preceding the norite, and the other pink and slightly more mafic, succeeding the norite. It is recognised that the Complex will long furnish genetic problems of fundamental importance to geologists and petrologists. In this paper the difficult questions of magmatic origins are touched on but lightly.

LAPLAND METEOROLOGY. — The observatory at Abisko, on Lake Torne in Swedish Lapland, has published its detailed observations for both 1926 and 1927. The headings to the tables are in Swedish and French. The usual meteorological data are given in full. In addition, there are a number of valuable records on the hydrology of the lake, including its weekly temperature at a depth of one metre, the dates of freezing and breaking up, and the thickness of the ice at weekly intervals during the long period from November to June, when the lake is frozen. Soil temperatures, on every fifth day throughout the year, are given for depths of 50, 100, 150, and 200 cm. There are also full notes on the displays of aurora borealis. These publications are valuable contributions to the study of Arctic Europe.

AUTOMATIC LEVEL GAUGE ALARM.—The application of photoelectric and selenium cells to operate alarms and automatic controls regulating the level of liquid in tanks and stand pipes is an interesting example of the growing industrial application of these instruments. The device is especially useful when the liquids are under high pressures, as then the standard methods of level control are inapplicable. The following simple arrangement is in use at the works at Billingham of the Synthetic Ammonia and Nitrates Limited. A glass inspection gauge is fitted at the required level on the stand pipe and the light sensitive relay is illuminated through the gauge. Using opaque liquids, the light is shut off when the liquid rises and the relay then operates an alarm signal. When transparent liquids are used, an opaque float in the gauge glass can be used to shut off the illumination when the liquid rises. Alternatively, the light sensitive relay and the light source may be mounted on the same side of the gauge glass and the relay illuminated by a beam reflected by total internal reflection at the inner surface of the glass. In this case reflection ceases when the liquid rises, the beam of light being refracted through the liquid. The latter method is convenient when flat gauge glass, to which a right angle prism can be cemented, is used.

PHOTOSYNTHESIS OF CARBOHYDRATES. — Prof. E. C. C. Baly's production of carbohydrates by the exposure to light of carbonic acid which had been deposited on the surface of nickel or cobalt carbonate, of which an account was given in the *Proceedings of the Royal Society* for 1927, has now been shown by him and N. R. Hood to show an additional resemblance to natural processes in its susceptibility to the influence of temperature (*ibid.*, A, vol. 122, p. 393, Feb. 4). The yield of carbohydrates in his experiments increases linearly with temperature to a maximum at 31°; photosynthesis by some algæ has been long known to obey a similar law, and it is now found that the temperature coefficients for the changes are almost the same in the two cases. Above 31°, the yield again decreases in his experiments, and becomes almost zero at about 48°; a botanical analogue of this is known in the existence of an optimum temperature for natural photosynthesis by leaves, with an assimilation-temperature curve which is very similar to that found by Prof. Baly, showing in particular a sharp peak at 37°. Prof. Baly has not discussed in any detail exactly what occurs in the purely physico-chemical processes with which he had been concerned, but it is evident from the similarities that he has pointed out that many of the characteristics of the natural phenomena are merely those of a pure photochemical surface reaction.

TRANSMUTATION OF ELEMENTS.—In an X-ray tube there is a large localised dissipation of energy in the neighbourhood of the focus-spot, where the electrons are incident on the anode. If it were possible to bring about transmutation by moderate quantities of energy, conditions here would appear to be particularly favourable, and any positive results obtained would carry considerable weight, since the substance being studied remains in a high vacuum throughout the experiment, and is thus not liable to chance contamination. At the suggestion of Prof. R. A. Millikan, tests of this nature have been made by L. Thomassen in the Norman Bridge Laboratory at Pasadena. His results, which are described in the February issue of the *Physical Review*, are completely negative; no change was found in the characteristic X-ray spectrum of a tungsten target before and after the tube holding it had been operated for three days at a peak potential of 207 kilovolts and a current of a few milliamperes. The same author has also repeated the experiments of Prof. Smits, from which it appeared at one time that lead might be transmuted into mercury, and has obtained no evidence of change in a lead arc, and inconclusive results with a high potential discharge between lead electrodes immersed in carbon disulphide, his conclusions in the latter case being similar to those afterwards arrived at by Prof. Smits himself (see NATURE, Jan. 2, 1926, p. 13, and Oct. 1, 1927, p. 475).

PHOTOCHEMICAL DECOMPOSITION OF NITROGEN PENTOXIDE.—The decomposition of nitrogen pentoxide in the presence of the dioxide, which photosensitises the reaction, using monochromatic radiation of wave-lengths 4350, 4050, and 3660 A., has been investigated by Baxter and Dickinson. Their results, which are described in the *Journal of the American Chemical Society* for January, appear to follow the mechanism suggested by Norrish. The first reaction is probably a decomposition of the dioxide into nitric oxide and oxygen. This is followed by a dark reaction between nitric oxide and nitrogen pentoxide: $NO + N_2O_5 = 3NO_2$. In the decomposition of nitrogen dioxide the quantum efficiency for radiation of wave-length 4350 A. is extremely low (0·0046 molecules of oxygen produced per quantum absorbed), and hence this wave-length should be ineffective for the decomposition of the pentoxide. This was actually found to be the case, since the effect with radiation 4350 A. was too small to be detected with the apparatus used.

The Eucalypts and Paper Pulp.

THE paper-pulp problem, especially with reference to what is termed newsprint or the material used by the daily press, is one of growing importance in many countries to those concerned. At first sight it would not, however, have been considered by the average man in Great Britain that the question had become one of importance in Australia; yet it appears that, with an annual consumption of 120,000 tons of newsprint, Australia comes next to the United States of America and Canada on the basis of requirements per head of population. None of this paper is made in Australia, the reason given being that "existing processes of manufacture require light-coloured coniferous wood that can be readily converted into pulp by purely mechanical means." This ground wood or mechanical pulp comprises 70 to 80 per cent of the fibre-content of newsprint, the remainder being pulp from the same wood chemically prepared by the sulphite process and added to impart the necessary strength to the sheet.

This being the position, the problem which has to be solved before newsprint can be manufactured in Australia is the discovery of a substitute for mechanical pulp that will compare with it favourably in the quality of the paper, as also in price. The problem is no new one. In India, investigations in connexion with various bamboos and grasses have been carried out at the Forest Research Institute for nearly a score of years past. So far as quality goes, previous investigations in Australia (*Bulletin* No. 25, Council for Scientific and Industrial Research. Melbourne: H. J. Green) have shown that it was possible to produce from the eucalypts bleached soda pulp much superior in quality to ground wood, and the indications were that on a large scale this pulp could be made at a cost not very much above the latter. Experimental work in this matter had been carried out in connexion with the mountain ash (*E. regnans*), Victoria; stringy bark (*E. obliqua*), Tasmania; gumtop (*E. delegatensis*), Tasmania; beech (*Fagus Cunninghamii*), Tasmania; and *Pinus insignis*. This work was, however, considered to be too incomplete to be worth publishing. In connexion with *P. insignis* it has been shown that it makes excellent sulphite pulp, as well-grown *P. insignis*, of 15-20 years of age, carry only about the same amount of resin as spruce.

More detailed researches have since been undertaken by Messrs. L. R. Benjamin and J. L. Somerville ("Paper-Pulp and Cellulose from the Eucalypts by the Sulphite Process." *Bulletin* No. 37, 1928). This bulletin deals with the research work carried out during the last four years on the problem of applying the sulphite process to the pulping of eucalypts from the practical viewpoint and bearing in mind the limitations imposed by existing industrial equipment. The authors, in discussing their objective, remark:

"The precedence in point of time accorded the soda pulping investigations was based entirely upon the fact that the so-called 'hardwoods' are seldom pulped by any other than alkaline processes. In this connexion it may be added that, by whichever process hardwood is pulped in other countries the product is almost invariably soft, bulky, and of low strength, its use being confined almost entirely to the manufacture of book papers in which the relatively high proportion of longer-fibred sulphite pulp from softwood is relied upon to impart the desired strength. In other words, hardwood pulp is used abroad as a filler for imparting softness and opacity. In *Bulletin* No. 25, previously referred to, it was shown, however, that pulp of good colour and high strength could be obtained from the eucalypts by a suitable modification of the soda process, followed by proper bleaching and heating. The experience thus gained has been of considerable value in the planning and conduct of the present investigation, one of the principal objects of which has been to find those cooking conditions that would give pulp possessing good strength and a colour sufficiently white, without bleaching, to be used, either alone or in high proportion, in the manufacture of newsprint. Other aspects have also been considered, such as the production of high-grade cellulose for use in the manufacture of artificial silk, but work in this direction has been restricted and mostly controlled by the necessity or desirability of acquiring evidence in support of certain trends, or of collecting incidental information that might be of value in establishing the proposed Australian newsprint industry."

The chemistry of the sulphite process, even at the present time, is incompletely understood, and there are many points connected with its application to the pulping of the eucalypts which the authors consider would well repay thorough investigation if the industry already existed in Australia, but they thought that for the present they should concentrate their investigations upon developing methods that would permit of ready application and be sufficiently economical to aid materially in the early establishment of the sulphite industry and the production of newsprint.

Those interested in this matter should consult this very interesting and valuable monograph. The authors' objects and results are expressed in the following:

"Preliminary investigations with the sulphite process pointed to the possibility of cheapening production to the required degree, and subsequent systematic study of the process has practically assured this, for it is now evident that bleaching can be eliminated and a pulp produced so much superior in quality to mechanical pulp, that the admixture of longer fibre for conversion into newsprint will probably not be necessary. Hence, as far as the production of a suitable substitute for mechanical pulp is concerned, the results of the present investigation indicate that this is entirely feasible.

"Apart from the demand for newsprint in this country, there is a large consumption of the better-grade printing papers and writing papers in which high-grade sulphite pulp is used. In addition to this there is a very heavy and increasing demand for artificial silk both in yarn and in the form of piece goods. These facts should stimulate the production of high-grade bleached cellulose once a newsprint industry relying on sulphite pulp is established. Accordingly, when it was found that the cooking conditions required for producing pulp sufficiently white in the unbleached state to be used in newsprint also closely approached those necessary for the production of high-grade cellulose, the opportunity was taken of exploring the possibilities further. As a result, considerable information on the physical qualities of the pulp, and the chemical purity of the cellulose produced in this investigation has been collected, and is now placed on record."

If this research work and experiments are translated into commercial operations, they should have an important outcome in the management of certain of the Australian forest areas. Their study will also repay countries in which the Eucalyptus has been successfully grown in plantations.

Natural History in Norfolk.

PROVINCIAL natural history societies may, and in many cases certainly do, perform very useful functions in keeping alive an active interest in Nature and the preservation of the local fauna and flora; but actual original work is generally confined to a small minority of members. Indeed, it is one of the chief difficulties in keeping such societies alive that the active members bear so small a proportion to the whole. A further difficulty exists when such societies also publish *Transactions*. On one hand, such a publication must, if it is to justify itself, maintain a certain standard of interest and originality; on the other, it is not advisable that it should be the medium of publication of original work of wide general interest, since the limited circulation of the journal makes it difficult of access, at all events in other countries. The papers published should deal primarily with the natural history, in its widest sense, of the locality, so the series of volumes should form a mine of trustworthy local information.

The Norfolk and Norwich Naturalists' Society has published its *Transactions* yearly, without a break, from its foundation in 1869, and has probably come as near as is possible to maintaining a general interest and value in its publications without going beyond its proper limitations. The part just published (vol. 12, part 4) opens with an account of the Mycetozoa by the president, Mr. H. J. Howard, illustrated by some remarkably fine photomicrographs, and including a complete list of the Norfolk species. Of the total of 121 species, Mr. Howard has added sixty to the county list, and among these one new to Britain and two varietal forms new to science. The paper should be of much value to anyone working at this group, by reason of the information given as to the nature of the habitat and season of appearance. A paper on the Swan Marks of East Norfolk, illustrated by figures of 160 of these marks, by Mr. Norman F. Ticehurst, embodies the results of an enormous amount of patient research and is of much more than purely local interest.

Prof. F. W. Oliver writes with his usual charm of a visit to Holland for the purpose of seeing the progress of experiments in reclamation by means of *Spartina Townsendi*. He has dealt with the subject in greater detail in other publications, but Norfolk has so much in common with Holland that what he has to say on this subject, and about the Nature reserves and flower culture in Holland, is of special interest to East Anglians.

A paper on the survey of Scolt Head Island by Mr. O. D. Kendall and Mr. J. A. Steers is a continuation of work intended to record the progressive changes in sand dunes and shingle banks due to tide and wind; two maps and a section illustrate the results of the survey.

Norfolk is fortunate in having the two National Trust properties of Blakeney Point and Scolt Head Island, both of which are being studied so effectively. Blakeney Point has already become famous from the work done by Prof. Oliver and his pupils, and at Scolt Head work on similar lines, under the supervision of Mr. Steers, is producing results of wide and permanent interest. The annual report of the Wild Birds Protection Fund again shows what excellent work in preservation of the local animal life can be done by provincial societies under the stimulus of an energetic personality. The Norfolk Wild Birds Protection Committee owes its existence to Dr. Long, and it is to him also that Norfolk owes the formation of the Norfolk Naturalists Trust, which owns a large area of marshes at Cley and intends to acquire other properties when the existence of rare birds seems likely to be threatened. The report includes some remarkable records of ducks shot at Hickling and Ranworth, those for the latter going back to 1920. From these figures it seems that the numbers of wildfowl are not, as has been supposed by some, on the decline.

The *Transactions* include also an article by Mr. Stuart Baker on the scientific results to be obtained by egg collecting, and a paper by Mr. Carruthers on planting at Scolt Head. The latter is of general interest, since much may be learnt from it as to the precautions to be taken in planting in such an exposed situation and on dunes.

The Storage of Food.

THE Report of the Food Investigation Board for 1927 [1] covers a wide range of problems connected with the subject of the storage of food, from purely scientific investigations to large-scale experiments on food transport and the necessary engineering practice. A considerable amount of work has been carried out on the transport and storage of fruit, especially apples, and on the changes taking place during storage which lead ultimately to its decay. Ships' holds are not air-tight, leaks occurring through hatches or wooden bulkheads between holds; from the low percentage of carbon dioxide frequently found, it appears that at least one-third of the air present may be changed daily. Well riveted steel bulkheads, however, allow of little leakage. The question is of importance, both from the point of view of maintenance of a particular temperature in the hold, and also because the storage life of fruit depends in part on the composition of the surrounding air. The conduction of heat from the ship into insulated holds along frames and beams projecting into the insulation, and the heat generated by the fruit itself in storage, have also to be taken into account in the design of refrigerators. At 20° C. sound apples generate heat at the rate of about 0·012 cal. per sec. per kgm., or 0·0015 cal. per sec. for an individual apple; in other words, an apple in 23 hours would raise the temperature of an equal weight of water 1° C. if there were no heat loss. In practice the temperature in the centre of the store is taken by means of a distance reading thermometer, of which a number of types have been studied.

Numerous investigations have been carried out on the changes taking place in apples during storage and the factors influencing them. It has been found that the smallest fruit have the lowest respiratory activity, and that the maximal rise in this activity is smaller and later than in larger apples: at the same time, the smaller apples usually have the longest life. A low respiratory activity therefore delays the onset of internal breakdown in storage. The nature of the soil on which the fruit is grown has a definite effect on storage life: apples off a heavy soil keep twice as long at 34° F. as those off a light soil, whilst the keeping quality is also correlated with the 'available' potash and phosphoric acid in the soil. The nitrogen content of different kinds of apples tends to remain fairly constant; a higher nitrogen content is associated with a

[1] Department of Scientific and Industrial Research. Report of the Food Investigation Board for the year 1927. (London: H.M. Stationery Office, 1928.) 4*s*. net.

higher respiratory activity. The amount of sucrose and acid present, however, varies considerably from one type to another, and is also affected by the nature of the season: thus cold weather raises the acid content, at the same time decreasing the sucrose value, warm weather having the reverse effect. By such changes season can alter the keeping qualities of the fruit, since life depends on the presence of respirable material. During storage the sugar and acid disappear at a constant rate and breakdown occurs when the store of respirable material is exhausted. Gas storage also delays breakdown by slowing the respiratory processes, but just before death there is a sudden increase in the utilisation of sugar.

It has been found that the optimum temperature for gas storage is higher than that used for cold storage: by gas storage is meant an increase in the carbon-dioxide concentration above 5 per cent, with a corresponding decrease in the oxygen percentage. Gas storage at a low temperature in fact accelerates internal breakdown; but at a temperature above about 40° F. gas storage gives better results than cold storage alone. In addition to the internal breakdown which occurs at low temperatures, appearing, however, only after six to ten weeks' storage, there is another type of breakdown which is hastened by higher temperatures and occurs especially in imported apples: it can be avoided by gathering the fruit before a certain critical stage of maturity on the tree has been reached and its onset is definitely delayed by cold storage.

In addition to breakdown, fruit in store may be attacked by fungal disease: the resistance of the fruit depends on a variety of factors, such as acidity, water, nitrogen, and potassium content, and hence on the locality in which the fruit is grown. A low water and nitrogen content and a high acidity and potash content are associated with a high resistance; the converse is also true.

Another problem which has been investigated is the best method of bringing cold-stored produce back to a normal temperature: a rapid rise in air temperature leads to wetting of the fruit from condensation of water on its surface, since its temperature only rises slowly. Two methods of preventing wetting are available: a slow and uniform rise in temperature or drying of the air during warming: which may be the better depends on knowledge of the rate of evaporation from the fruit to be warmed, a problem which requires further investigation under practical conditions.

Further work has also been carried out during the year on meat and fish and their products. The conditioning of beef hung at a temperature of 41° F. has been studied: there is a progressive increase in tenderness especially noticeable in the coarser joints or in inferior quality carcasses, and even after 17 days the meat is still perfectly sweet.

It is now well known that, to obtain meat fit for consumption, freezing should be rapid to avoid the formation of large ice crystals: when the crystals are only small, on thawing the meat closely resembles fresh meat. It has now been found that bacon can similarly be frozen and be edible on thawing again, but the temperature necessary is considerably lower than that required for meat or pork. For pork, – 10° C. may be sufficient; but for mild cured bacon, – 15° C. at least is necessary for rapid freezing, the freezing point of the bacon being several degrees below that of pork. The practicability of freezing bacon at – 15° C. and then storing it at – 10° C. is now being examined.

Investigations of fish by-products have included the nutritive value of fish meals and the use of fish skins as a substitute for isinglass. It was found that seabream meal in the diet of pigs resulted in better growth than was given by the best white fish meal or blood meal and sterilised bone flour: moreover, the growth was made at a smaller expense in food than in the case of ordinary fish meal, a fact of considerable commercial importance. Similar results were obtained with rats, and the seabream meal also produced better calcification of the bones than white fish meal. The seabream is an oily fish which is not much used for human consumption. Work has also been carried out on the nature of the sterols in marine animals and on the constitution of squalene and certain of the higher alcohols, problems which may be found to have a bearing on the storage or use of the various products for human consumption.

University and Educational Intelligence.

CAMBRIDGE.—The Council of the Senate has presented a report to the University on an offer by the Medical Research Council to equip a Nutritional Laboratory on a site at the Field Laboratories, and has recommended that the offer be gratefully accepted.

LONDON.—The University College Committee will award in June next a Bayliss-Starling Memorial Scholarship of the value of about £120 (with exemption from tuition fees). Candidates may be graduates or undergraduates of approved standing in science or in medicine. The Scholar will be required to follow a course of study approved by the Jodrell professor of physiology involving a training in the principles and methods of research in physiology and/or biochemistry. Applications must be submitted on or before May 15, to the Secretary of University College, London (Gower Street, W.C.1).

A movement has been for some time in progress to endow the chair of engineering at University College in order to commemorate the great and enduring influence of the late Sir Alexander Kennedy on engineering education. This appeal has met with a wide response: nearly £19,000 has been raised of the £30,000 required. In a letter supporting the appeal, the presidents of the Royal Society and of the Institutions of Civil, Mechanical, and Electrical Engineers direct attention to Kennedy's pioneer work and the need of a permanent memorial. Subscriptions may be sent to Lord Meston, the Treasurer of this Fund, at University College.

MANCHESTER.—The University has received a bequest of £300 under the will of the late Miss Amy Henrietta Worswick. In accordance with the wishes of the testatrix, the bequest will be devoted to the investigation of the causes and treatment of rheumatoid arthritis. A temporary fellowship of the value of £150 per annum will be offered, and application may be made to the Registrar before Oct. 15 next by any person who has obtained a medical qualification registrable in Great Britain.

The University council has appointed Dr. D. R. Hartree, lecturer in mathematical physics at the Cavendish Laboratory, to the Beyer chair of applied mathematics in succession to Prof. E. A. Milne. Dr. Hartree was educated at Bedales School and at St. John's College, Cambridge, of which he was an entrance scholar. He took the Mathematical Tripos, Part I., in 1916, and the Natural Science Tripos, Part II. (Physics), in 1922, his course being interrupted by the War. With the rank of lieutenant, R.N.V.R., he carried out research in ballistics and the calculation of high-angle trajectories whilst in the Anti-Aircraft Experimental Section of the Munitions Inventions Department. He was elected to a fellowship of St. John's College in 1922 and became a fellow of Christ's College in 1928.

Calendar of Patent Records.

March 17, 1693.—During the seventeenth century there was a large number of patents granted in connexion with apparatus for working under water. One such was granted to John Stapleton on Mar. 17, 1693, for "a new engine soe by him contrived as to permitt a person inclosed in it to walk under water, and of a new invented way to force air into any depth of water to supply the person in the said engine therewith and for continuing a lamp burning under water; also a way to deserate and purifye the air so as to make the same serviceable for respiration." No further details of the apparatus are given.

March 17, 1768.—The art of making porcelain from native materials was unknown in England until William Cookworthy, chemist, of Bristol, discovered deposits of the requisite materials, kaolin and petuntse, in Cornwall and Devon. Cookworthy was granted a patent for the manufacture on Mar. 17, 1768, and established a factory at Plymouth, where the first china made of native clay was produced. The patent was afterwards acquired by Richard Champion of Bristol, and was extended by Parliament.

March 18, 1780.—On Mar. 18, 1780, there was granted to Louis Recordon, watchmaker, of London, the first patent for a self-winding watch. The re-winding was effected by a heavily weighted but lightly balanced lever which was connected to the main-spring spindle and was given sufficient motion to wind the spring by the ordinary movements of the wearer. Breguet, the famous French watchmaker, made several watches with a similar device, and those that exist to-day are said still to work satisfactorily.

March 18, 1862.—To Thomas Dunn, of Manchester, belongs the honour of having filed the largest patent specification. This was lodged in connexion with his patent dated Mar. 18, 1862, for "Improvements in the construction of bridges, roofs, houses, and other structures," and comprises 36 pages of description and 104 sheets of drawings. It was printed at a total cost of more than £650, and formed a volume about 8 in. thick which sold at the price of £2, 13*s.* a copy. The specification is very comprehensive, and includes the construction of bridges, reading rooms, floating fortifications, suspension roofs for railway stations, portable sheet-metal buildings, churches, etc. One of the most interesting proposals is the construction of elevated lattice-work footbridges with spiral staircases which were especially designed to enable pedestrians to cross the busy streets of London, several examples of which are illustrated in the drawings. Dunn was a prolific inventor, twenty-three patents standing to his name in the printed indexes for improvements in machinery of all kinds.

March 20, 1787.—The practical application of machinery to the shearing of cloth, a necessary process preparatory to printing, is due to the Rev. John Harmar, whose first patent for a cropping machine is dated Mar. 20, 1787. In spite of a great deal of opposition the invention was extensively adopted, especially in the west of England, and was in use for many years.

March 23, 1869.—The synthesis of alizarin, the colouring matter of the root of the madder plant and the first of the natural dye-stuffs to be produced artificially, was the work of Carl Liebermann and Carl Graebe of Berlin, who were granted a Prussian patent for five years for their invention on Mar. 23, 1869. Commercial production of the synthetic alizarin was commenced the following year by the Badische Anilin- und Sodafabrik by a process the English patent for which anticipated by one day an application from W. H. Perkin for an identical process.

Societies and Academies.

LONDON.

Royal Society, Mar. 7.—**T. M. Lowry** and **A. G. Nasini**: The molecular dimensions of organic compounds. Part 1: General considerations. A comparative study of the physical properties of benzene with thiophen, toluene with α-methylthiophen, benzene with cyclohexane, all pairs with similar boiling and freezing points, shows that the vapours exhibit regular increments rather than identity of properties; and the physical properties of the liquids and solids, depending on force-fields of molecules as well as on dimensions, show still wider differences.—**A. G. Nasini**: The molecular dimensions of organic compounds. Part 2. An apparatus, based on Rankine's method, has been constructed for measuring the viscosity of vapours, and Sutherland's constant and the mean collision area deduced for benzene and cyclohexane.—Part 3. A further modification of the apparatus is described, in which a zero pressure is used on the condensation side of the capillary. The viscosities of thiophen, methylthiophen and pyridine have been determined.—**W. A. Bone** and **R. P. Frazer**: A photographic investigation of flame movements in carbonic oxide–oxygen explosions. A theoretical $2CO + O_2$ mixture is exploded at atmospheric pressure under varying conditions, such as 'dryness,' 'source and intensity of ignition,' as well as under the influence of superimposed 'shock waves' up to and including detonation. The new Fraser high-speed photographic machine was used. Progressive drying reduces flame velocity and hinders combustion, but the hindering effect can be overcome by a strong electric field. With superimposed 'shock waves' the speed at which a flame starts may be raised in successive abrupt steps until it attains a speed approaching that of the 'shock waves themselves.'—**H. S. Patterson, R. Whytlaw-Gray**, and **W. Cawood**: (1) Some observations on the condensation of water on smoke particles. Particles of non-hygroscopic smokes readily absorb water, thus increasing in size, if a small quantity of hydrogen chloride is present.—(2) The process of coagulation in smokes. Experimental graphs, especially for systems of low concentration, show distinct curvature in the direction indicated by theory. Smokes which are most nearly homogeneous give coagulation graphs closely in agreement with Smoluchowski's theory as modified for aerial systems. The smokes studied are formed by molecular collision rather than by condensation around pre-existing nuclei.—(3) The electrified particles in smokes. A method has been worked out for counting directly charged and uncharged particles. The particles of low temperature volatilisation smokes are initially almost entirely uncharged particles, but the proportion of charged particles rises rapidly. Arc smokes and magnesium oxide smokes are highly charged from the start.—(4) The structure of complex smoke particles. Arc smokes often consist of aggregates of great complexity, composed of minute particles, while smokes produced by volatilisation at lower temperature have much simpler structure.—**J. G. Semple**: Cremona transformations of space of four dimensions by means of quadrics and the reverse transformations.—**S. Goldstein**: On the vortex theory of screw propellers. When the distribution of circulation along the blades of a screw propeller is such that, for a given thrust, the energy lost in the slip-stream is a minimum, then the flow far behind the propeller is the same as if the screw-surface formed by the trailing vortices was rigid and moved backwards along its axis with a constant velocity.—**O. W. Richardson** and **P. M. Davidson**: The spectrum of H_2: the

bands analogous to the parhelium line spectrum. Part 2. The data give a spectroscopic ionisation potential of H_2 is 15·380 volts. This compares with Pauli's value 23·7 volts on the old quantum mechanics and with $15{\cdot}26 \pm 0{\cdot}13$ estimated from Burrau's computations on the wave mechanics using Witmen's value of the heat of dissociation of H_2.—**R. C. Johnson** and **R. K. Asundi**: A new band system of carbon monoxide. Details are given of a new system corresponding to the transition $3'S \rightarrow 2'P$.—**I. Waller** and **D. R. Hartree**: On the intensity of total scattering of X-rays. General results due to Waller for radiation scattered by a many-electron atom (neglecting 'relativity effects') are used to give an approximate formula for intensity of total (coherent and incoherent) scattering of X-rays.—**C. M. White**: Stream-line flow through curved pipes. A mathematical discussion indicating that for large disturbances, flow in curved pipes is more stable than flow in straight pipes, which is in opposition to the opinion that curvature tends to instability.—**H. A. Wilson**: The theory of cracking petroleum. Calculations are based on theory of chemical equilibrium in mixtures of hydrocarbons discussed in previous papers. When liquid fraction is greater than 50 per cent, calculated gasoline fraction is nearly independent of temperature and pressure, but depends on composition of oil. When all oil is just vaporised the gasoline fraction is nearly the same in all cases. Amount of oil cracked per day in a given reaction chamber at given temperature and pressure is inversely as gasoline fraction.—**A. Fowler**: The arc spectrum of silicon. By passing an arc in nitrogen at atmospheric pressure, and using a vacuum spectrograph, the arc spectrum of silicon has been photographed to about λ1600. Comparison with singly ionised phosphorus, P II, shows the general similarity expected.—**S. F. Grace**: Internal friction in certain tidal currents.—**T. L. Ibbs** and **A. A. Hirst**: The thermal conductivity of gas mixtures.—**D. M. Newitt, B. J. Byrne,** and **H. W. Strong**: Equilibrium in the system methyl alcohol—hydrogen—carbonic oxide.—**W. A. Bone, F. R. Weston,** and **D. A. Winter**: Further experiments on the combustion of well-dried carbon monoxide and oxygen mixtures. Part 3.—**E. K. Rideal** and **O. H. Wansbrough-Jones**: An investigation on the combustion of platinum.—**R. W. Ditchburn** and **F. L. Arnot**: The ionisation of potassium vapour.—**H. J. Gough** and **H. L. Cox**: The behaviour of a single crystal of zinc subjected to alternating torsional stresses.—**F. C. Lea**: The penetration of hydrogen into metal cathodes and its effect upon the tensile properties of the metals and resistance to repeated stresses.—**W. T. Astbury**: A new integrating photometer for X-ray crystal reflections, etc.—**T. H. Havelock**: The dispersion of double refraction in quartz.—**W. L. Bragg**: The determination of parameters in crystal structures by means of Fourier series.—**W. G. Bickley**: Two-dimensional potential problems concerning a single closed boundary.—**P. M. S. Blackett**: On the design and use of a double camera for photographing artificial disintegration.

Linnean Society, Feb. 14.—**E. E. Edwards**: On the morphology of the larva of *Dorcus parallelopipedus* L. Apart from other characters, the larva of *Dorcus* can be separated from those of other European genera of Lucanidæ by the form and arrangement of the tubercles composing the coxæ and trochanteric stridulatory areas. In its internal anatomy it exhibits affinities with certain genera of Scarabæidæ. The nervous system is of an exceptionally primitive character as in *Lucanus*, and does not exhibit the great concentration of the ganglia of the ventral nerve-cord prevalent in larvæ of the allied family Scarabæidæ.—**A. G. Lowndes**: Variation in Arctic freshwater Entomostraca. Many species of freshwater Entomostraca are cosmopolitan in their distribution, and there appears to be no correlation between the difference in environments with variation shown by the separate species.—**S. R. Bose**: The biology of wood-rotting fungi. Viala's culture medium and sterilised wood blocks from which the air had been driven were used. Sporophore formation occurred only in those cultures exposed to light, and was usually associated with poor vegetative growth. When fruit-bodies were formed, they usually occurred on the upper end of the slant towards the glass surface. This is probably related to moisture conditions and the check of vegetative growth.

CAMBRIDGE.

Philosophical Society, Feb. 11.—**T. M. Lowry**: Configuration of quadrivalent atoms. The evidence which led Werner in 1893 to assign a planar configuration to platinous salts of the type $[2NH_3 . PtCl_2]$ is similar to that advanced by Vernon for tellurium and now disproved by Drew, who assigns to quadrivalent tellurium the same tetrahedral configuration as to sulphur. X-ray analysis, however, has assigned a planar configuration to the anions of the tetragonal crystals of $K_2[PtCl_4]$, $K_2[PtCl_4]$ and $Am_2[PdCl_4]$.—**F. G. Mann**: The stability of complex metallic salts. αβγ-Triaminopropane co-ordinates very firmly around the 6-co-ordination octahedron, and in consequence divalent nickel, zinc, platinum and palladium all give salts containing the bis-triaminopropane-metallic complex $[\{NH_2 . CH_2 . CH(NH_2) . CH_2 . NH_2\}_2M]''$. Each metal has adopted the unusual (and in the case of divalent platinum, and palladium, quite abnormal) co-ordination number of 6 in order to provide the octahedron necessary for maximum stability of the completed complex salt. This accounts for their unexpected stability.—**F. H. Constable**: An apparatus for the study of gas reactions on electrically heated films of known area. Electrodeposition on a graphite foundation, from a moving electrolyte, is used to produce metallic films. The area is found by the interference method. Carbon films are produced on graphite by the thermal decomposition of hydrocarbons. While the area of a particular carbon film by the methylene blue adsorption method appears to be 6·8 times the plane area, the area from sections drawn to scale showing irregularities greater than 5×10^{-4} cm. is of the order of twice the apparent area.—**C. P. Snow**: The structure of the nitric oxide molecule. The vibration and rotation spectrum of nitric oxide has been studied upon a large infra-red spectrometer specially designed for the analysis of bands into fine structure. There is found to be one vibration band.

PARIS.

Academy of Sciences, Feb. 4.—**Georges Claude**: The utilisation of the thermal energy of the sea. The experimental plant successfully operated last year at Ougrée is to be transferred to Cuba. It is arranged to work on the difference of temperature between the temperature of the water at sea-level and that at a depth of about 600 metres. The tube will be two metres in diameter and two kilometres in length.—**T. A. Janczewski**: Theorems of oscillation for differential systems of the fourth order.—**R. Wavre**: The problem of the figures of equilibrium of a fluid heterogeneous mass.—**Joseph Pérès**: The actions of a viscous fluid on an obstacle. The case of the ellipsoid.—**P. Noaillon**: Sketch of a new theory of the resistance of fluids.—**Henri Malet**: The propagation of light in the ether.—**L. Mallet**: The ultra-violet radiation of substances submitted to the gamma rays. When pure liquids, such as water, are submitted

to the gamma high frequency radiation, light is emitted. The continuous spectrum of this light appears to be limited by the natural absorption of the excited liquid.—**Pierre Auger**: The influence of the level of origin of the photoelectrons on the distribution in space of their initial directions.—**A. Boutaric**: Remarks on the formulæ representing adsorption isotherms. A comparison of the formula of Freundlich and that of Jean Perrin.—**Pierre Jolibois** and **Louis Chassevent**: The reactions between colloidal silica and lime. The reactions between silica and lime in solution are due to three phenomena, the coagulation of the silica by the lime, the combination of the lime and silica giving a hydrated calcium silicate, followed by adsorption of the lime. In solutions rich in lime this adsorption continues for months.—**R. Bureau**: The experimental study of the zones of silence in the propagation of short [wireless] waves. As a provisional explanation, which further data may cause to be modified, it is suggested that the ionised layers of the upper atmosphere play the principal part but in certain critical cases a very slight modification may decide between two different paths through the ionised layers.—**M. and Mme. A. Chauchard**: The influence of ischemia on the excitability of the cerebral cortex.—**Maurice Fontaine**: The increase in the consumption of oxygen by marine animals under the influence of high pressures. Its variations as a function of intensity of compression.—**Raymond-Hamet**: The glucosides of *Digitalis purpurea*. After a summary of the results obtained by various workers on the toxicity of commercial preparations from digitalis, an account is given of the direct comparison of the toxicity of crystallised digitaline (Nativelle) and pure digitoxine (Cloetta). From experiments on 120 dogs, the physiological activity of these two products was found to be identical.—**Maurice Piettre**: Some properties of serum-albumen: its crystallisation in the absence of any ionogenic element. The application of the acetone method, which permits the analytical separation of the proteins and their preparation in the pure state, has solved the problem of the crystallisation of albumen, without any ionogenic element being present.—**Marage**: The choice of an ear-trumpet.—**Georges Blanc, J. Caminopetros, J. Dumas**, and **A. Saenz**: Experimental researches on the sensibility of the lower apes to the virus of dengue. Various species were inoculated with the blood of men suffering from dengue. None of the animals showed any clinical signs of the disease and there was no rise of temperature, but their blood, which was non-virulent twenty-four hours after inoculation, became virulent between the fifth and eighth days. The apes thus treated were immune for at least fifty days.

COPENHAGEN.

Royal Danish Academy of Science and Letters, Oct. 10.—**Niels Bohr**: Quantum theory and relativity. An examination of the difficulties brought to light by the attempts at reconciliation of the quantum postulate with the idea of relativity seems to require a further revision of our fundamental physical concepts as regards their application to atomic phenomena.

Nov. 2.—**Ejnar Hertzsprung**: Proper motions of faint stars in the Pleiades. Provisional results of an investigation in progress. Comparison of old and new plates of the Pleiades taken at different observatories mainly in order to pick out the faint physical members of the group by aid of their common proper motion.—**August Krogh**: The biological assay of insulin. After mentioning the degree of purity attainable in insulin preparations which is ascertainable by chemical assay, a comparison is given of biological methods.

Nov. 16.—**J. N. Brønsted**: The kinetics of ethylene oxides. The apparent basicity of ethylene oxides is explained on the basis of kinetic measurements in aqueous solutions of various composition. It has been possible by these measurements to verify the conclusions of recent theories on reaction velocity. The results obtained have also some bearing upon the general problem of the nature of acids and bases.

ROME.

Royal National Academy of the Lincei, Nov. 18.—**Gino Fano**: Birational contact transformations of the plane.—**U. Cisotti**: Concerning two recent notes by M. Pascal and C. Ferrari.—**U. Cisotti**: Hydrodynamic actions in the proximity of salients.—**A. L. Herrera**: Investigations on the imitation of organised forms with albumen and mineral acids (2). Further structures resembling those of unicellar organisms or of cellular tissues are described. The forms obtained exhibit no evolution or motion; they may be stained with hæmotoxylin and preserved in glycerol.—**R. Calapso**: A transformation of the surface *R*.—**R. Caccioppoli**: The expression of the area of a surface by means of a double integral.—**Silvia Martis in Biddau**: Calculation of the logarithm of a matrix of the second order, and its application to the study of groups of one parameter containing a given substitution.—**V. Glivenko**: The probable values of functions.—**E. Cech**: Asymptotic correspondences between two surfaces.—**E. Pistolesi**: Further with regard to the Kutta-Joukowski theorem in the case of the plane strip.—**G. Viola**: Elliptical elements of the system of U Ophiuchi.—**A. Carrelli**: The theory of sensitised fluorescence. A treatment is given of the phenomenon of sensitised fluorescence on the basis of undulatory mechanics, the method followed being that by which Born elaborated the theory of inelastic shock between the electron and the material atom.—**V. Polara**: Gibb's theorem (phase rule) for heterogeneous equilibria.—**G. Bargellini**: 2 : 6-Dichlorophenetidine. The results of earlier experiments indicated that the dichlorophenetidine prepared by Jaeger by passing hydrogen chloride through an alcoholic solution of *p*-nitrosophenol is probably the 3 : 5-, but possibly the 2 : 6- compound. The latter has now been prepared in another way and proves to be different from Jaeger's compound, which is therefore 3 : 5-dichlorophenetidine.—**G. Mezzadroli** and **E. Vareton**: Influence of metallic magnesium on the formation of formaldehyde and sugars by the action of ultra-violet rays on solutions of calcium bicarbonate. The reducing power (towards iodine solution) developed on exposing calcium bicarbonate solutions to ultra-violet rays attains a maximum after 30 minutes if open basins, or after an hour, if closed vessels of transparent quartz are used; the yield of reducing substances is higher in the latter case. The presence of metallic magnesium in the solutions increases the total quantity of reducing substances formed, and induces the formation of sugars capable of reducing Fehling's solution and of giving an osazone.—**G. Spagnol**: Experiments on the fixation of colloids caused by chloroform. If colloidal mercuric sulphide is injected into the auricular vein of a rabbit and a wad of cotton-wool soaked in chloroform is simultaneously applied for 15 seconds to the animal's side, a sharp black stain of the sulphide is found in the subcutaneous connective tissue under the chloroformed spot when the rabbit is killed—after 2 hours or 8 days. Similar fixation of Trypan blue is observed.—**A. Desio**: Presence of the miocene in Sirtica.—**G. Brunelli**: The epoch of reproduction of *Delphinus*.—**M. Tirelli**: Studies on the physiology of insects (nervous system).—**A. Barchiesi**: Histophysiological investigations on the influence of variations of temperature in certain organs of heterotherms.

Official Publications Received.

BRITISH.

Memoirs of the Geological Survey of India. Vol. 53: The Structure and Correlation of the Simla Rocks. By Dr. Guy E. Pilgrim. Pp. vi+140+xix. (Calcutta: Government of India Central Publication Branch.) 4 rupees; 6s. 9d.

Journal of the Indian Institute of Science. Vol. 11A, Part 16: i. α-*Iso*propylglutaconic Acid, by K. V. Hariharan, K. N. Menon and J. L. Simonsen; ii. Derivatives of Methyl 2:2-Dimethyl*cyclo*pentan-3-one-1-Carboxylate, by C. S. Gibson, K. V. Hariharan and J. L. Simonsen. Pp. 207-220. 12 annas. Vol. 11A, Part 17: i. Thiophthalic Acids, Part 1, by Gopál Chandra Chakravarti; ii. Organic Cyclic Polysulphides, Condensation of Ethylene Mercaptan with Di- and Trichloracetic Acids, by Gopál Chandra Chakravarti and Jogendra Mohan Saha. Pp. 221-230. 8 annas. Vol. 11A, Part 18: Bio-Semidine Inversion in Aromatic Dihydrazo Compounds. By Praphulla Chandra Guha and Hirendra Kuman Banerjee. Pp. 231-239. 8 annas. (Bangalore.)

FOREIGN.

Appendix No. 2 to Annual Report of the Chief of the Bureau of Navigation, 1928: Annual Report of the Naval Observatory for the Fiscal Year 1928. Pp. iii+38. (Washington, D.C.: Government Printing Office.)

Department of the Interior: Bureau of Education. Bulletin, 1928, No. 18: Private and Endowed Schools offering Trade and Industrial Courses. By Maris M. Profitt. Pp. iii+50. (Washington, D.C.: Government Printing Office.)

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 8, 1926. iii: Vattenståndеn vid rikets kuster. Pp. 21. 2.00 kr. Årsbok, 9, 1927. v: Hydrografiska mätningar i Sverige. Pp. 25+4 plates. 5.00 Kr. (Stockholm.)

Memoirs of the College of Science, Kyoto Imperial University. Series A, Vol. 11, No. 6. Pp. 451-551+10. (Kyoto.)

State of Connecticut: State Geological and Natural History Survey. Bulletin No. 43: The Life Forms of Connecticut Plants and their Significance in relation to Climate. By Dr. Beulah Ennis. (Public Document No. 47.) Pp. 100+20 plates+v. (Hartford, Conn.)

Diary of Societies.

FRIDAY, MARCH 15.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botanical Lecture Theatre, Imperial College of Science and Technology), at 2.30.—Sir John Russell: Some Agricultural Problems in Australia.—F. L. McDougall: The Commonwealth Council of Science and Industry in its Relation to Agriculture.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 4.30.—Thunderstorms and the Maintenance of the Earth's Electric Field. Chairman, Prof. S. Chapman. Discussion to be opened by Prof. E. V. Appleton, and continued by R. A. Watson Watt, Dr. G. C. Simpson, Prof. C. T. R. Wilson, and T. W. Wormell.

BIOCHEMICAL SOCIETY (Annual General Meeting) (in Department of Physiology and Biochemistry, University College), at 4.30.—I. S. MacLean: Further Observations on the Sterols of Yeast.—H. J. Channon and A. C. Chibnall: The Isolation of n-nonacosane and di-n-tetradecyl Ketone from Cabbage Fat.—J. G. Davis and A. T. R. Mattick: The Metabolism of a Pigmenting Anaerobic Bacterium.—G. N. Richardson and R. K. Cannan: Reaction of Azine Compounds with Proteolytic Enzymes.—B. C. Guha and Prof. J. C. Drummond: Observations on the Concentration of Vitamin B_1.—Prof. J. C. Drummond, R. A. Morton, and K. H. Coward: A Critical Examination of the Methods for the Assay of Vitamin A.—C. R. Harington and S. S. Randall: Isolation of 3:5-diiodotyrosine from the Thyroid Gland.

MEDICAL OFFICERS OF SCHOOLS ASSOCIATION (Annual General Meeting) (at Society of Medical Officers of Health, 1 Upper Montague Street), at 5.—Sir Henry Gauvain: The Combined Education of Children Suffering from Physical Defects.

BRITISH INSTITUTE OF RADIOLOGY (Medical Meeting), at 5.—Discussion on Urinary Cases.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration of Recent Advances in our Knowledge of the Anatomy and Physiology of the Gall-Bladder.

BRITISH PSYCHOLOGICAL SOCIETY (Æsthetics Section) (at Bedford College), at 5.30.—Mrs. Roberts (Susan Miles) and others: Discussion on Inspiration.

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (Annual Meeting) (at Liverpool University), at 6.—L. O. Newton: Boiler Feed Water.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—F. C. Johansen: Research in Mechanical Engineering by Small-Scale Apparatus.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Newcastle-upon-Tyne), at 6.—J. H. Gibson: Mechanical and Transmission Losses in Marine Engines, Shafting, and Propellers.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 6.15.—C. F. J. Morgan: Wave-form Analysis.

ROYAL AERONAUTICAL SOCIETY (at 7 Albemarle Street), at 6.30.—L. T. Brown: The Napier Lion Engine.

SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (at Glasgow), at 6.45.—Annual Meeting.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (Annual General Meeting) (at Cardiff Technical College), at 7.—T. G. Watts: The Co-ordination of Chemical Industry and Chemical Societies.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group) at 7.

SOCIETY OF DYERS AND COLOURISTS (Glasgow Section) (at 7 Gordon Street, Glasgow), at 7.15.—F. Asquith: The Necessity of Application of Fast Colours on Textile Fabrics.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30—T. Grime: Locomotive Rating.

ROYAL SANITARY INSTITUTE (at Town Hall, Torquay), at 8.—G. J. Loveless: The Plumber and Public Health.

ROYAL SOCIETY OF MEDICINE (Obstetrics Section) (jointly with Maternity and Child Welfare Group of the Society of Medical Officers of Health), at 8.—Discussion on The Future of the Maternity Services.—Openers for Section of Obstetrics: Prof. J. M. M. Kerr and E. Holland.—Openers for Society of Medical Officers of Health: Dr. E. Hill and Dr. J. J. Buchan.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Dr. W. S. Whitcombe: Intensive Ionisation.—Dr. A. B. MacLean: The Prone Position as a Routine Method in the X-ray Examination of the Stomach, with a Note on the Question of Retractability of the Stomach.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. V. M. Goldschmidt: The Distribution of the Chemical Elements.

SOCIETY OF DYERS AND COLOURISTS (Manchester Section).—Short Papers.

SATURDAY, MARCH 16.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South Midland District) (at Uxbridge), at 10.30 A.M.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South-Western District) (at Guildhall, Bath), at 11 A.M.—Annual District Meeting.

BRITISH MYCOLOGICAL SOCIETY (at University College), at 11.—C. R. Metcalfe: Shab Disease of Lavender.—Dr. G. H. Pethybridge: Exhibit of an Unusual Hypertrophy in Potato Tubers due to *Spongospora*.—Miss K. Sampson: Some Observations on *Epichloe typhina* (Pers.) Tul.—R. S. Vasudeva: On the Parasitic Invasion of Apple Fruit by Various Fungi.—W. R. D. Weston: The Relative Resistance of some Wheat Varieties to *Tilletia Caries* (DC.) Tul. (T. Tritici Wint.).

PHYSIOLOGICAL SOCIETY (Annual General Meeting) (at University College), at 3.—M. C. G. Israëls and F. W. Lamb: Carbon Dioxide Equilibria between Mixed Venous Blood and Rebreathed Airs.—Dr. J. S. Haldane: Claude Bernard's Conception of the Internal Environment.—A. Hemingway and J. M. Peterson: The Action of Oxytocin and Vasopressin on the Perfused Isolated Kidney.—Prof. R. S. S. McDowall: The Central Chemical Control of the Heart Rate.—A. P. Gorer and M. S. Pembrey: Observations upon the Respiratory Exchange of Hibernating Mammals.—R. E. Havard and P. M. T. Kerridge: A Change in the Hydrogen-ion Concentration of Blood after Shedding.—Ruth Deansley: The Effect of Toxins on the Adrenal Gland.—G. F. Marrian: The Assay of Œstrin.—A. R. Fee and Dr. A. S. Parkes: The Mechanism of Ovulation in the Rabbit.—A. R. Fee: Experimental Water Diuresis.—A. R. Fee and E. Ogden: Physiological Significance of the Renal Portal System.—E. Leyko: The Action of some Heart Tonics.—E. Leyko and J. Mehes: The Action of Ephedrine.—J. P. Bouckaert: Efficiency and Fenn Effect in Tortoise Muscles.—J. P. Bouckaert, F. Cappellen, and J. De Blenite: Value and Significance of the Constants of Muscle Viscosity.—H. Florey, A. Szent-Györgyi, and M. E. Florey: Methods for Testing for the Presence of Adrenal Cortex Hormone.—M. Grace Eggleton and Prof. C. Lovatt Evans: The Formation and Disappearance of Lactic Acid.—Demonstrations:—M. C. G. Israëls and F. W. Lamb: A Modified Henderson Automatic Sampler for Alveolar Air.—E. W. H. Ellis: (*a*) A Water Driven Centrifuge; (*b*) Variable Speed Gear; (*c*) Artificial Lung with Bakerlite Plates (Bayliss, Fee and Ogden); (*d*) A Perfusion Tap; (*e*) Perfected Roller Pump (Bayliss).—G. E. S. Ward and S. Wright: Human Electrocardiographic Curves During and After Nitrous Oxide Anæsthesia.—Dr. B. A. McSwiney: A Frog's Heart Chamber.—A. R. Fee and Dr. A. S. Parkes: The Effect of Hypophysectomy (by Decerebration) on Ovulation in the Rabbit.—J. P. Bouckaert: Apparatus for Measuring Muscle Viscosity Extension-time Curve.—F. Gairns: Microscopic Demonstration of Nerve Endings.—Prof. A. V. Hill: The Increment, due to Stimulation, in the Resting Anaerobic Heat-Rate of Muscle.—R. J. Lythgoe: (*a*) Test Types; (*b*) Apparatus for Study of Visual Acuity. [Mezzanine.]—W. S. Duke Elder, P. M. Duke Elder, and J. Colle: The Optical Registration of the Intra-ocular Pressure.—E. Bozler: The Heat Production of Smooth Muscle.—F. R. Winton: A Thermostat, Constant to One-thousandth of a Degree Centigrade at Body Temperature.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Molecular Motions in Rarefied Gases (III.).

GEOLOGISTS' ASSOCIATION (North-East Lancashire Group) (at Blackburn Technical College), at 7.—J. Ranson: The Evolution of the Craven Highland.

HULL ASSOCIATION OF ENGINEERS (at Technical College, Hull), at 7.15.—G. E. Petty: Aeroplane Design.

MONDAY, MARCH 18.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Rev. A. H. Finn: Conjectural Emendations in the Psalms.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—C. E. Shattock: Demonstration of Specimens illustrating Diseases of the Testis.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—M. Isacco: The Helicogyre.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section, London), at 6.30.—K. Brinsmead: Locomotive Lubrication.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—C. Turnbull and others: Discussion on Method in Invention.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—E. Y. Robinson: Radio Sets on the Mains.

BRADFORD TEXTILE SOCIETY (at Midland Hotel, Bradford), at 7.30.—W. Bell: Banking and Commerce.

HUDDERSFIELD TEXTILE SOCIETY (at Huddersfield Technical College), at 7.30.—H. Wilkinson: The Practical Routine of Piece Dyeing.

SOCIETY OF CHEMICAL INDUSTRY AND INSTITUTE OF CHEMISTRY (Edinburgh and East of Scotland Sections) (at 36 York Place, Edinburgh), at 8.—J. A. Reavell: Heat Transmission.

CHEMICAL INDUSTRY CLUB, at 8.—Dr. C. Singer: Hygiene and History.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—O. G. S. Crawford: Air Photographs of the Middle East.

TUESDAY, MARCH 19.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. R. A. Young: A Medical Review of the Surgery of the Chest (Lumleian Lectures) (I.).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Dr. S. W. Kemp: Antarctic Whaling Expeditions (II.).

MINERALOGICAL SOCIETY, at 5.30.—A. W. Groves and A. E. Mourant: Inclusions in the Apatites of some Igneous Rocks.—L. A. Narayana Iyer: Calc-gneisses and Cordierite-sillimanite-gneisses of Coimbatore, Madras Pres., and of Similar Occurrences in India.—F. A. Bannister: A Relation between the Density and Refractive Index of Silicate Glasses with Application to the Determination of Imitation Gem-stones.

ROYAL SOCIETY OF MEDICINE (General Meeting), at 5.30.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. C. J. Van der Klaauw: On the Development of the Tympanic Region of the Skull of the Macroscelididæ.—Lilian Russell: The Comparative Morphology of the Elysioid and Æolidioid Types of the Molluscan Nervous System and its Bearing on the Relationships of the Ascoglossan Nudibranchs.—S. Maulik: On the Structure of the Hind Femur of Haltcine Beetles.—J. W. Winterbottom: Studies in Sexual Phenomena—Communal Display in Birds.—Capt. C. R. S. Pitman: Notes on the Vertebrate Fauna of Nkosi Island, Lake Victoria, Uganda, Africa.

INSTITUTION OF CIVIL ENGINEERS, at 6.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (jointly with East Midland Sub-Centre) (at Loughborough Town Hall), at 6.45.—Ll. B. Atkinson: How Electricity does Things (Faraday Lecture).

ELECTRICAL ASSOCIATION FOR WOMEN (at 15 Savoy Street), at 7.—H. Bourne: Some Elementary Facts concerning Electric Motors.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7.—T. N. Riley and T. R. Scott: Electrical Insulating Papers for the Manufacture of Power Cables.—S. G. Brown and P. A. Sporing: The Prevention of Ionisation in Impregnated Paper Dieletrics.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (Associate Members' and Graduates' Branch) (at Milton Hall, Manchester), at 7.—A. E. Cubbage: Address.

ILLUMINATING ENGINERING SOCIETY (at 15 Savoy Street), at 7.—W. Maitland: Architectural Lighting.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Kinematograph Group), at 7.—E. E. Lamb: Demonstration of Bell and Howell Kinematograph Cameras and Projectors.—B. W. Hanchett: A New System of Studio Lighting for Panchromatic Film, with Mercury Vapour Lamps.

INSTITUTE OF METALS (Birmingham Local Section) (at Engineers' Club, Birmingham), at 7.—Dr. N. F. Budgen: Aluminium.

INSTITUTE OF METALS (North-East Coast Local Section) (at Armstrong College, Newcastle-upon-Tyne), at 7.30.—Annual General Meeting and Exhibition.

INSTITUTION OF AUTOMOBILE ENGINEERS (Inventors' Evening) (at 83 Pall Mall), at 7.45.

MANCHESTER ATHENÆUM TEXTILE SOCIETY (at Manchester).—H. P. Curtis: Cloth Faults.

WEDNESDAY, MARCH 20.

INSTITUTION OF NAVAL ARCHITECTS (Annual Meeting) (at Royal Society of Arts), at 11.—Admiral of the Fleet Lord Wester Wemyss: Presidential Address.—Sir William J. Berry: H.M. Battleships *Nelson* and *Rodney*.—Lieut.-Col. F. Dondona: Sea Trials of Italian Destroyers.

INSTITUTION OF CHEMICAL ENGINEERS (Annual Corporate Meeting) (at Grosvenor House, Park Lane), at 12.15.—Sir Alexander Gibb: The Co-ordination of Engineering Institutions and Societies (Presidential Address).—At 2.15.—Prof. B. P. Haigh: Chemical Action in Relation to Fatigue in Metals.

SOCIETY OF GLASS TECHNOLOGY (at Leeds University), at 2.30.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Sir Douglas Mawson: Some South Australian Algal Limestones in Process of Formation.—Dr. A. W. Groves: The Unroofing of the Dartmoor Granite, and an Outline of the Distribution of the Detritus in the Sediments of Southern England.

INSTITUTION OF ELECTRICAL ENGINEERS (Tees-Side Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.—R. W. Gregory: Electric Supply to the Rural Districts of England.

TEXTILE INSTITUTE (London Section), at 7.—H. Clayton and others: Informal Discussion on Fabric Printing.

INSTITUTION OF ELECTRICAL ENGINEERS (Sheffield Sub-Centre) (in Mappin Hall, Sheffield), at 7.30.—Prof. W. Cramp: The Cause and Effect of Oscillation in Electrical and Mechanical Apparatus.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—R. A. Watson Watt: Weather and Wireless (G. J. Symons Memorial Lecture).

ROYAL MICROSCOPICAL SOCIETY, at 7.30.—Capt. M. A. Ainslie, C. Beck, J. W. Gordon, Sir Herbert Jackson, Prof. A. W. Porter, and J. Rheinberg: Discussion on paper by Dr. H. Moore on The Mode of Formation of the Image in the Microscope.

ROYAL SOCIETY OF ARTS, at 8.—Prof. A. E. Richardson: Modern English Architecture.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

ROYAL SOCIETY OF MEDICINE, at 9.15.—Dr. L. Williams: Napoleon III.

THURSDAY, MARCH 21.

INSTITUTION OF NAVAL ARCHITECTS (Annual Meeting) (at Royal Society of Arts), at 11.—J. Johnson: The Propulsion of Ships by Modern Steam Machinery.—Dr. J. Bruhn: Some Considerations Regarding International Loadline Regulations.—At 3.—Dr. G. Kempf: New Results Obtained in Measuring Frictional Resistance.—C. F. A. Fyfe: The Practical Use of the First British-Built Bauer-Wach Exhaust Steam Turbine Installation in the Booth Liner *Boniface*.—At 8 P.M.—Prof. C. E. Inglis: Natural Frequencies and Modes of Vibration in Beams of Non-Uniform Mass and Section.—S. A. Hodges: The Behaviour of Stiffened Thin Plating under Water Pressure.

CHEMICAL SOCIETY (Annual General Meeting) (at Leeds University), at 4.30.—Prof. J. F. Thorpe: Co-operation in Science and Industry (Presidential Address).

ROYAL SOCIETY OF MEDICINE (Dermatology and Epidemiology Sections), at 4.45.—Special Discussion: Industrial Dermatoses, their Causation, Recognition, Prevention, and Treatment.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. R. A. Young: A Medical Review of the Surgery of the Chest (Lumleian Lectures) (II.).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Rev. W. H. Draper: Change of Meaning of Words from One Period to Another.

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

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Hon. Sir Charles A. Parsons and J. Rosen: Direct Generation of Alternating Currents at High Voltages.—J. A. Kuyser: Recent Developments in Turbo-Generators.

INSTITUTION OF THE RUBBER INDUSTRY (Manchester and District Section) (at St. Mary's Parsonage, Manchester), at 7.—Dr. G. Barr: Ageing of Cotton contained in Rubber Goods.

INSTITUTION OF AUTOMOBILE ENGINEERS (Western Centre) (at Technical School, Gloucester), at 7.30.—L. W. Johnson: The Inspection of Metals and their Alloys.

BATLEY AND DISTRICT TEXTILE SOCIETY (at Public Library, Batley), at 7.30.—J. Brooke: Practical Hints on Carding.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (Laboratory Meeting) (at Royal Army Medical College), at 8.15.—Demonstrations by Dr. Mary Andrews, Major E. E. Austen, Major H. C. Brown, Dr. W. T. C. Broom, Major S. Elliott, Dr. E. Hindle, Dr. A. C. Stevenson, Col. S. P. James, Col. W. P. MacArthur, Dr. J. C. Ray, Major D. T. Richardson, and Dr. V. B. Wigglesworth.

ROYAL SOCIETY OF MEDICINE (Urology, Pathology, and Therapeutics Sections), at 8.30.—Special Discussion: Urinary Antiseptics.

FRIDAY, MARCH 22.

INSTITUTION OF NAVAL ARCHITECTS (Annual Meeting) (at Royal Society of Arts), at 11.—Eng. Rear-Admiral W. Scott-Hill: Powdered Coal for Ships.—A. Spyer: Modern Developments of the Water Tube Boiler for Marine Purposes.—Eng. Rear-Admiral A. E. Hyne: Suggested Modifications to Marine Water Tube Boilers.—At 3.—J. Rennie Barnett: Motor Life-Boats of the Royal National Life-Boat Institution.

TEXTILE INSTITUTE (Lancashire Section) (at Manchester), at 1.15.—J. W. Cooling: Air Conditioning Apparatus, including Humidifying and De-Humidifying.

ROYAL SOCIETY OF MEDICINE (Disease in Children Section) (Clinical Meeting at Royal Free Hospital), at 4.30.

PHYSICAL SOCIETY (Annual General Meeting) (at Imperial College of Science), at 5.—Dr. W. H. Eccles: Presidential Address.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration on the Nerve Supply and Movements of the Colon.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—Annual General Meeting.

INSTITUTION OF LOCOMOTIVE ENGINEERS (North-Eastern Centre) (at Hotel Metropole, Leeds), at 7.—T. Robson: Experiments on Buffer Springs.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—H. Lambert: Warm Tones on Chloro-Bromide Papers.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE (Annual General Meeting) (at Royal Technical College, Glasgow), at 7.—F. G. Martin: Elastic Limit Steel.

BLACKBURN TEXTILE SOCIETY (at Blackburn Technical College), at 7.30.—A. J. Hall: The Dyeing and Finishing of Cotton Piece Goods containing Artificial Silk.

LEICESTER TEXTILE SOCIETY (at Victoria Hall, Leicester), at 7.30.—S. Kershaw: Faults in Yarns.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—D. A. Collin: Ventilation.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Ernest Rutherford: Penetrating Radiations.

SATURDAY, MARCH 23.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Molecular Motions in Rarefied Gases (IV.).

PUBLIC LECTURES.

SATURDAY, MARCH 16.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—J. E. S. Dallas: Saxon Churches and their Remnants.

MONDAY, MARCH 18.

EAST ANGLIAN INSTITUTE OF AGRICULTURE (Chelmsford), at 7.—W. R. Dunlop: The Economy of Labour in Farming.

TUESDAY, MARCH 19.

BEDFORD COLLEGE, at 5.15.—Sir Herbert Baker: Modern Tendencies in Architecture.

SATURDAY, MARCH 23.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—M. A. Phillips: Mammals of Britain.

DISCUSSION.

FRIDAY, MARCH 15.

FARADAY SOCIETY (at Chemical Society), at 2.30 and 4.30 (*continued from March* 14).—Crystal Structure and Chemical Constitution:—

Part II. Organic Compounds:—Sir William Bragg: Introduction.—Dr. A. Müller: A Hydrocarbon Model.—Dr. H. S. Piper: Limitations in the Method of Identifying Long Chain Compounds by a Measurement of their Spacings.—Mrs. K. Lonsdale: X-ray Evidence on the Structure of the Benzene Nucleus.

Part III. Metals:—Dr. J. D. Bernal: The Problem of the Metallic State.—Prof. A. F. Westgren and G. Phragmén: X-ray Studies on Alloys.

Part IV. General:—Prof. A. Reis: On the Intensity, Sharpness, and Reducibility of the Debye-Scherrer Lines.—Prof. H. Mark: The Methods of Determining the Size and Shape of Small Crystals.—Dr. K. Weissenberg: Lattice Determination in Polycrystalline Aggregates.—Dr. W. T. Astbury: An Integrating Photometer for X-ray Crystal Reflections.—Dr. N. H. Kolkmeijer: Allotropy and the Determination of Densities by X-rays.—Prof. P. P. Ewald: Report on Recent Developments of Wave Mechanics and its Bearing on Crystal Structure.