NATURE

SATURDAY, DECEMBER 8, 1928.

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Editorial and Publishing Offices:

MACMILLAN & CO., LTD.,

ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.

Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.

Telegraphic Address: PHUSIS, WESTRAND, LONDON.

No. 3084, VOL. 122]

Woodlands of Great Britain.

THE report on the "Census of Woodlands and Census of Production of Home-grown Timber, 1924," recently issued by the Forestry Commission,[1] is an interesting production, since it records, probably for the first time, the approximate areas, nature, and conditions of the woods of Great Britain. In England and Wales most of the data were collected by public-spirited private individuals, selected for their knowledge of particular districts. In Scotland the work was done by the Forestry Commissioners' "regular local correspondents" (the term appears obscure), and by the technical staff. The six-inch Ordnance map was used, and the acreage of all woods exceeding 2 acres in extent was marked on the maps. These maps were then sent to the individual proprietors concerned, who were asked to indicate on the map the type and age-classes of their woods. The census was commenced in the autumn of 1921, but was not completed until the end of 1926. The year 1924 has been adopted as the date of the census, as most of the work was carried out in that year, and adjustments have been made from the statistics collected in other years.

Whilst this census cannot be compared for accuracy with those made by a highly trained and skilled staff, as, for example, the census recently undertaken for the forests of Sweden, it has for present purposes a very distinct value, since it enables us to know, if only roughly and approximately, the types of the various woods in existence in Great Britain, and the probable amount of material of various classes they contain.

For the purposes of classification, the woods were divided into two main groups, 'Economic' and 'Uneconomic,' with a third group under which optional information might be furnished on the subject of the degree of stocking of the individual woods. Economic woods are defined as areas maintained primarily for timber production; uneconomic woods are "those areas which are not maintained for timber production, but primarily serve some other purpose." These were most unfortunate definitions to adopt, as it at once ensured the classification as 'uneconomic' of every acre of woodland which the assessor could not regard as a commercial proposition. Yet there are many woods in Great Britain which, although their purpose may have been primarily sport, shelter, or amenity, produce materials which

[1] Forestry Commission. Report on Census of Woodlands and Census of Production of Home-grown Timber, 1924. Pp. 68. (London: H.M. Stationery Office, 1928.) 1s. 9d. net.

are utilised by the local population and have been so used for centuries. At the present day and with changing conditions, it is dangerous to label any area of woodland as 'uneconomic.' Out of the 3,000,000 acres of woods in Great Britain there are probably very few to which the term would apply—for very often the value of a tract of woodland is not primarily connected with its timber-producing capacity—a fact fully accepted by the experienced professional forester. This subdivision influences to a marked degree the methods upon which the results of the census are tabulated. Under economic or potentially productive we have—conifers, 671,840 acres; mixed conifers and hardwoods, 301,690 acres; hardwoods, 443,340 acres; or a total of 1,416,870 acres. Given separately under the same group are coppice and coppice-with-standards, 528,670 acres; scrub (poor coppice areas and so forth), 330,700 acres; and felled and/or devastated, 478,100 acres. Under uneconomic, the amenity woods, shelter belts, etc., amount to 204,290 acres.

Nearly half the area of hardwoods consists of oak woods. It may be agreed that a considerable portion of this area is not under the best forest management, and that present-day fellings are making heavy inroads into the old growing stock. In the interests of the country, it is to be hoped that the major portion of this area will be maintained under oak and other suitable valuable hardwoods, and that they may not be replaced by the conifer. The census shows that the large area of 528,670 acres consists of coppice and coppice-with-standards. Much of this is in poor condition, but there appears to be little doubt that the introduction of a good system of management would result in a considerable proportion of this area becoming a paying proposition. Far more serious is the disclosure that no less an area than 808,800 acres consists of scrub and felled or devastated areas. This large area includes considerable tracts felled during the War. It would appear a somewhat grave reflection on the forest policy of Great Britain that a more energetic effort should not have been made to replant a larger portion. For, in the case of the felled areas, the valuable humus layer built up through the years the former crop stood on the ground is becoming dissipated and the soil thereby impoverished.

The census will have fulfilled a valuable object if it leads to a realisation of the fact that a true forest policy for Great Britain should include steps to safeguard and improve all the woodland areas and forest soils of the country.

Norman Lockyer's Work and Influence.

Life and Work of Sir Norman Lockyer. By T. Mary Lockyer and Winifred L. Lockyer, with the assistance of Prof. H. Dingle, and contributions by Dr. Charles E. St. John, Prof. Megh Nad Saha, Sir Napier Shaw, Prof. H. N. Russell, the Rev. J. Griffith, Sir Richard Gregory, and Prof. A. Fowler. Pp. xii + 474 + 17 plates. (London: Macmillan and Co., Ltd., 1928.) 18*s*. net.

THIS book is essentially for those who know and use NATURE and knowing it wish to understand the man who brought it into being—as a child of quite unusual vigour and distinction—giving to it, almost from its birth, the individuality and strength of character which have long made it everywhere the recognised organ of scientific opinion: the *Times* of science. The achievement was his great contribution to scientific advance, of far greater value, I venture to say, because of the effect it has had in promoting the appreciation of scientific endeavour, than his work as an inquirer—which was largely that of a seer, in advance of his time, needing interpretations that only later additions to knowledge were to make possible. Still, the spirit of discovery was at the root of his being: from it he derived his force and it gave to him his success. Wise men like Huxley, seeing this in him, became his willing slaves.

The establishment of NATURE, now fifty-nine years old, was a literary, not a scientific feat, yet one needing for its success a rare combination of qualities—not merely literary but also editorial ability, breadth and intensity of scientific outlook and social qualities of an unusual force and range. The journal was not a financial success until after thirty years. To have kept the enterprise alive, during so long a period, was an astounding exercise of determination, diplomacy and skill. Lockyer was never an easy man to get on with. At times impetuous, often intolerant, always impatient beyond measure and most assertive, from an early date he held scientific workers generally at his behest. His whole-hearted unselfish devotion to his enterprise, his high aims, the importance to us of its success, the difficulty of the work—were so clearly recognised that we all rallied to his standard. There was a feeling that the journal had to be. NATURE is a power to-day because of the sure foundations he laid: upon this his successor—long his assistant and most severely trained in his service—during the past nine years, has been able

to build broadly and judicially, to meet the needs of all schools of scientific activity and opinion, without fear or favour. NATURE has been lucky in her assistants—Keltie and Gregory. Is the succession secure? I tremble, in asking the question, by the way.

In this connexion, I may direct attention to the following passage in "The Earlier Life and Letters of Walter H. Page."

"Consider the making of a periodical: what is the difference between a fairly good one and a really great one? It is only the difference of personalities and ideas that go into them. This is so simple that it sounds silly to state it. But there is no secret about making a great magazine. You must have, of course, a good craftsman at the head of it, a man of editorial skill, of good judgement, of some courage and of character but these are all common qualities and with all these you will make but a fairly good magazine. The stuff to make a great periodical of is yet lacking and this stuff is a prodigality of ideas—such as no one man has or can have. Ideas must grow about it with the very luxuriance of nature, must come to it from every quarter. It must have enough waste material to make all the other periodicals better than they are now. This requires more than the acquaintance and goodwill and casual suggestions of fertile men; *it requires, to a degree, the identification of their personalities with it*" (my italics).

It is because Lockyer was pre-eminently successful in securing 'the identification of the personalities' of scientific workers and of advanced scientific opinion of the day with his journal, that he made NATURE what it is and that his successor is successful. Page necessarily feigned modesty in appraising the qualities needed in an editor and set these far too low. Editors must be peculiar people to succeed: far more than good craftsmen. NATURE has been a success, because Lockyer wove for it a magic carpet upon which scientific workers in all subjects could be attracted to sit: to preserve this in effective condition can never be an easy task.

The story of Lockyer's life and work is told in the book in a general biography covering 226 pages, written by Prof. H. Dingle, upon material compiled by Miss Lockyer and Lady Lockyer with remarkable completeness. Then follow chapters by various writers appreciative of the several sections of his scientific and special work. From the general biography, we learn everything material in his career—in fact, it is possible to trace almost his daily occupation. Although most explicit, in a measure, the account is rather lacking in feeling—it is the work of a writer who has not known his subject sufficiently closely and at the early critical period of his activity to paint a really intimate picture. It is, in fact, as are so many portraits—technically good yet not quite the man himself. At times, the story is a little exaggerated, if not misleading, at least to one who, like myself, lived through the period under notice and was a close follower of all that happened, even sometimes behind the scenes. Probably Lockyer is best summed up in some of the doggerel current in early days: such as—

> There was a young astronomer called Lockyer,
> Who each year grew cockier and cockier,
> Till he thought he was owner of the solar corona,
> Did this young astronomer Lockyer;

or the following amusing item in a programme of an entertainment on shipboard on one of the eclipse expeditions to India: "Mr. Lockyer will play upon his own trumpet: Wait until the clouds roll by!"

In early days, Lockyer was irrepressible, overflowing with energy and enthusiasm, at times displaying an overmastering tendency to fill the picture, often making the rashest assertions. The unco' guid dryasdusts were a little shocked by such conduct. Fortunately he had a large circle of friends able to discount his little foibles, who gave him their support. The element of a strong personal vanity was undoubtedly there, you saw it in him, yet behind all such display there was clearly nothing but generosity and the desire to make others share with him the intensity of his belief in the value of scientific purpose. He had no academic training; to his great advantage, I think, he was self-taught and unhampered by professional prejudice.

Norman Lockyer was born at Rugby on May 17, 1836. His grandfather practised as a surgeon-apothecary at Kensington and his father was intended for the same profession but apparently never qualified. He settled eventually at Rugby, where "he found opportunities for indulging his liking for scientific pursuits," founding, with the help of others, the Rugby Literary and Scientific Institution, of which he became secretary and treasurer. He frequently lectured, first on chemistry, then on electricity. He even experimented on telegraphy. To carry out his work for the Literary and Scientific Institution, he obtained a printing press. He also had a taste for astronomy. It is easy to see, therefore, whence his son Norman derived his proclivities and breadth of outlook.

At thirteen, Norman Lockyer went to live with his uncle, Mr. Norman, at Ashow in Warwickshire, and attended a school at Kenilworth, where he became proficient in Latin. When twenty years old, he spent about a year in Switzerland, studying French and German; at this time he became a proficient French speaker. In February 1858, he became a Civil Servant, securing a clerkship in the War Office, by competitive examination. He then married and settled at Wimbledon.

Through one of his friends there, George Pollock, a barrister, Lockyer came into touch with Thomas Cooke, the famous optical glass maker. In 1861 he purchased a $3\frac{3}{4}$ in. Cooke telescope and set it up in his garden. He began to write articles on astronomical subjects. No doubt, Cooke was impressed by his enthusiasm for he lent him a $6\frac{1}{4}$ in. object glass; this was put into a papier maché tube and mounted on a rough iron stand in the garden. With this instrument, he did all his work until he went to South Kensington in 1871. Having observed a transit of the satellite Titan across Saturn, he sent an account to the *London Review* of May 10, 1862. This brought him a letter from the editor, Little, asking for occasional notes and a monthly article on "The Face of the Sky." This was the beginning of his career as a pressman. He was also encouraged by a letter from Dawes, a well known astronomical observer of the day. The earliest astronomical work of permanent value he did was on Mars; this brought him into touch with leading astronomers.

In 1863, Lockyer became scientific editor to the *Reader*, a review of literature, science and art, started by his nieghbours J. M. Ludlow and Tom Hughes. The articles and summaries he contributed covered the whole range of science. At this period, his literary activity was very great and he also came forward as a popular lecturer. He left Wimbledon early in 1865 for West Hampstead, where an observatory was built for his $6\frac{1}{4}$ inch Cooke refractor. His first spectroscopic observations of the sun were made in this year. Apparently, in conversations with Balfour Stewart, in 1866, he formed the idea that the nature of the flames seen around the darkened sun at an eclipse could be determined with the spectroscope: he was unable with the instrument at his disposal to effect his object. Thinking that it was not sufficiently powerful, he made application for a government grant, which he obtained early in 1867. An instrument was ordered from Browning but was not ready until October 1868. On the morning of Oct. 20 he obtained the expected result and at once sent a communication to the Royal Society.

By the strangest coincidence, the French astronomer, Janssen, had observed, in India, the total eclipse of the sun on Oct. 18: impressed by the spectrum of bright lines afforded by the prominences, the idea then occurred to him which had long been in Lockyer's mind. The next day he was able to see the lines in full daylight. The two observers had independently witnessed the same phenomenon for the first time. It is remarkable that the two communications came before the French Academy of Sciences at the same meeting. The French government formally recognised that honours were divided, by striking a medal bearing on the one side the portraits of the two astronomers in profile.

Lockyer found himself lionised. Little wonder that he henceforth became wedded to the instrument which had served him so well: armed with it he plunged into the sun. He appears to have been led to become a laboratory worker by his desire to account for the strong yellow line in the spectrum of the chromosphere which was unobtainable from any element then known. Frankland, at this time, was engaged in studying the combustion of hydrogen under high pressure and had formed the opinion that the sun did not, as had been assumed, consist of ignited solid or liquid matter but that the photosphere, at least, consisted of gases or vapours only. He had naturally been greatly interested in the recent spectroscopic discoveries and I believe invited Lockyer to join him in studying the hydrogen spectrum very carefully. Alexander Pedler, who had been my junior fellow student, was detailed for the work, MacLeod doing some of the glass blowing. In three short papers they published together, they were able to throw much light upon the condition of hydrogen in the prominences but the yellow line was not unmasked. Lockyer, as all know, soon afterwards came to the daring conclusion that it was an indication of an unknown element, which he named helium—a name even more happily chosen than that which he gave to his journal. The forecast was verified by Ramsay's isolation of the gas twenty-six years later. I was in the chair at the Chemical Society, about to give my presidential address, when the discovery was announced, just after I had presented the Society's Faraday medal to Lord Rayleigh for his discovery of argon—a dramatic moment.

Frankland's name has been associated with the discovery. In the general biography (p. 42) the

statement is made that in 1872 Frankland, in a letter to Lockyer, pointed out that he was not then and never had been satisfied that the line was not due to hydrogen. Lady Lockyer has most kindly given me a copy of the letter and with her permission I reproduce it.

Sept. 9th. 1872

DEAR LOCKYER,

I am just reading Dr. Carpenter's address to the British Association and at p. 7 find the following :—" But when Frankland and Lockyer, seeing in the spectrum of the yellow (!) solar prominence a certain bright line not identifiable with that of any known terrestrial flame, attribute this to a hypothetical new substance which they propose to call Helium, it is obvious that their assumption rests on a far less secure foundation."

Surely Dr. Carpenter is wrong in coupling my name with yours in connection with Helium as I remember always protesting, in our conversations about the yellow line, against making this assumption, until we had exhausted every effort to get the line out of hydrogen. Will you kindly let me know whether any such statement in our joint names has ever appeared.

I should have been quite ready to share with you the responsibility that the sun's chromosphere contains incandescent hydrogen ; indeed I consider that the proofs of this which we have obtained are even more convincing than would be the " capture of a flask of it " and its conversion into water.

Dr. Carpenter's statement that our assertion is founded upon " a certain line " shows that he has not read our papers on the subject.

Believe me,

yours very truly,

E. FRANKLAND.

In a later letter, Frankland wrote :—" I have written to Carpenter about Helium and asked him to put it right." We are carried back a long way by Frankland's phrase—" I should have been quite ready to share with you the responsibility that the sun's chromosphere contains incandescent hydrogen," etc.

I confess, after reading the story of his early life, that it is a surprise to me to learn that Lockyer was so fully qualified both for his editorial and his scientific work, by heredity—astronomy was in his blood—and early training and occupation. When he came upon the scene as solar chemist, the idea prevailed among us that he was but a War Office clerk and amateur astronomer, in no way a trained worker. He flashed into view as a new star, clearly of irregular orbit. My first acquaintance with him was in 1870, soon after my return, early in the year, from Germany. He was then under Frankland's sober and sure guidance. He became an independent worker in 1873, when he acquired the laboratory at South Kensington which he gradually developed into the Solar Physics Laboratory. It was here that he started chasing the elements with a view to their downfall. He was entirely without training for the task. Everything, in turn, was sealed up in a hard glass tube, provided with a spark gap, attached to the Sprengel pump—and became duly dissociated. Unfortunately, hydrogen was the usual product. He was so innocent a chemist, so anxious to justify his hypothesis, that I and others had great difficulty in persuading him that hydrogen was unavoidable, not the product of *elementary* dissociation. He soon passed over to safer ground—to the systematic study of the solar spectrum, still with the vision of ' dissociation ' ever before his eyes. Late in 1878, he came forward openly with the thesis that, under solar conditions, the elements were dissociated into simpler elements —stating his case at great length in a paper laid before the Royal Society in December of that year.

The biography is a little misleading upon this matter. We are told that the view was revolutionary and that he found himself at variance with the general trend of scientific thought. This is not an accurate presentation of the situation. The view was not a novel one—the possibility was never doubted : the objection taken was rather to Lockyer's ' slap-dash ' way of proving his case. His interpretation of much of the spectroscopic evidence he advanced was thought to be unsatisfactory ; especially was this true of his attempt to establish the existence of lines common to several elements. To be plain, much of his work was not trusted ; exact workers like Dewar and Liveing and Huggins simply would not listen to him ; even his friends Frankland and Roscoe shook their heads.

I am able to speak with inner knowledge. Lockyer, who was very anxious to have his work made public, insisted on my acting as his interpreter and to this end secured from the *Times* a request that I would write an article upon the reception of his paper. To the best of my belief, the article, more than a column long, on p. 3 of the *Times* of Dec. 18, 1878, commencing " At a crowded meeting such as is seldom witnessed, etc.," came from my pen. The position was a very difficult and delicate one : how far I carried diplomacy will be evident from the following quotations—

" There can be no question that the facts brought forward are of the highest importance and value and that they will have much influence on the

further development of spectrum analysis . . . his arguments are of a character so totally different from that ordinarily dealt with by chemists that they will hesitate for the present to regard them as proof of the decomposition of the elements until either they are assured by competent physicists that they cannot be explained by any other equally simple and probable hypothesis or until what Mr. Lockyer has foreshadowed as taking place to such an extent in other worlds has been realised beyond question or cavil in our own laboratories. . . . Chemists are careful to teach that what are at present regarded as elements are not necessarily simple bodies but merely substances which they are unable to decompose or which they have no special reason to regard as compound bodies. The remarkable relations, both in atomic weight and properties, existing between many of the elements tend, indeed, to show that they are related in the manner Mr. Lockyer supposes. We sincerely hope that he will continue his researches in this direction and we trust that at no very distant time he may be able to bring forward evidence sufficiently clear to convince even the most sceptical."

We now know, as is made plain in the book, in several of the special articles, that Lockyer had glimpsed a radiant vision, though much of his argument must be regarded as unsound, as was contended by his critics: the time was not ripe for its interpretation but to-day we willingly admit that he was the gifted seer, far in advance of his age. Happily his own school has contributed largely to the consolidation of his reputation—Prof. Fowler, in particular.

From destruction, Lockyer passed to construction and evolved his meteoritic hypothesis. He next sought to connect up archæology with astronomy. Finally, he let his imagination play over the field of university education. All these phases of his activity are considered by competent writers.

The general picture is one of astounding activity and fertility of imagination: whatever his shortcomings as a worker, he stands before us now a man of great achievement: of great penetrative power, a devoted public servant, one to whom the scientific fraternity is indebted to an extent which probably few can realise. NATURE is the story of science in its making. Lockyer planned for it a great future. We can but show regard for his memory by assisting to carry on the work, in the spirit in which he always wrought, to advance natural knowledge, in the service not merely of industry but also in the far higher service of man's faith in the eternal verity of natural law—in the belief that scientific method is the method that will ultimately prevail.

HENRY E. ARMSTRONG.

The Home of the Gurkhas.

Nepal. By Perceval Landon. Vol. 1. Pp. xxiii + 358 + 8 plates. Vol. 2. Pp. viii + 363 + 7 plates. (London: Constable and Co., Ltd., 1928.) 63*s.* net.

THOSE who are familiar with the temples and palaces of China and Japan will be fascinated by the beautiful photographs of Nepalese buildings contained in Mr. Landon's book. In Nepal, Mongolian architecture reached its zenith. Not only was the Nepalese architect a master of his art, but he was also assisted by expert wood carvers and metal workers who beautified the doors, windows, and eaves of every building with bold and original designs. The photographs, unfortunately, can give no hint of the colour of the buildings. In the text we read of rose-tinted walls, black woodwork, and brilliantly painted eaves. The buildings themselves we can never see, for the frontiers of Nepal are closed to Europeans.

The reasons for this exclusion are religious and political. In the eyes of its inhabitants, Nepal is holy ground, which would be defiled by the foot of a foreigner. During the nineteenth century the rulers of Nepal watched the British trader pushing in from the coasts across the plains of India, and hard on his heels followed the soldier and administrator. The British came to trade, but stayed to govern. If the British trader was allowed to cross its frontiers, the independence of Nepal would not long survive. The British and Indian Governments approve of the closing of the Nepalese frontiers, and no European may enter the country, unless invited to do so. Our knowledge of the country must therefore be based on observations made by a very few individuals who visit the country as guests of the ruler. Mr. Perceval Landon was one of these; he went to Nepal in 1924.

The first volume of Mr. Landon's book is devoted to the history of Nepal. There are very few trustworthy records, as the Nepalese historian was more concerned with flattering individuals than with setting down the truth. Buddha was born in Nepal, and at the date of his birth the country was apparently part of some Indian kingdom. It is probable that for many centuries a succession of Indian potentates claimed it as part of their possessions, though the warring hill tribes who inhabited the country were, in fact, independent. When the Moslem conquerors swept across India they failed to penetrate into Nepal, but they drove into it many Hindus, who brought about a revival of the Hindu religion.

The Gurkhas, who are now the dominant race, were originally a small tribe, ruled by the King of Gorkha, a petty town from which they take their name. By cunning and violence they gradually made themselves masters of the whole country, but their conquest was not completed until 1769. Their next exploit was a raid into Tibet, which in turn provoked reprisals from China. The Chinese drove the Gurkhas out of Tibet, and pursued them through Sikkim into Nepal. Finally, peace was made when the Chinese were within a few miles of Katmander; the Gurkhas accepting a nominal Chinese suzerainty. The Gurkhas then attempted to extend their kingdom towards the west, but were checked by the Sikhs under Ranjit Singh. After a pause they tried to expand towards the south, and this led to a clash with the East India Company. After a British column had penetrated into Nepal, a treaty of peace was signed in 1816, and the foundations were laid for the firm friendship between the Gurkhas and British, which has now been maintained for more than a century.

Mr. Landon devotes a chapter to the fate of Nana Sahib, who was responsible for the massacre of British women and children at Cawnpore during the mutiny. He escaped to Nepal, and for many years all trace of him was lost. His relatives declared he was dead. There is, however, some evidence to show that in 1895 he was wandering in India, destitute and imbecile.

In the second volume of his book Mr. Landon deals with the present conditions. The King of Nepal takes no active part in the government. The country is ruled by a Prime Minister, whose powers are unlimited, and who holds office for life. The present Prime Minister, Maharajah Chandra Sham Sher, is the maker of modern Nepal. He favours the introduction of such Western ideas and inventions as are not likely to undermine the religion or government of the country. His foreign policy may be summed up as "Nepal for the Gurkhas, and friendship with the British." It should be remembered that Nepal is an independent State. No political developments in India can affect the Government of Nepal, except indirectly.

At present there is little trade between Nepal and the outside world. In the future, considerable quantities of timber may be exported from the Tarai, the malarial forest belt which borders on India. The mineral wealth of the country has not been explored. Nepal's chief export is the Gurkha soldier. During the War, more than 200,000 Gurkhas left their country for active service. Few nations contributed so large a proportion of their manhood.

The religion of Nepal is a compromise between Hinduism and Buddhism. As the ruling families are Hindus, the Hindu aspect is now the more emphasised, and increasing importance is attached to caste.

Mr. Landon's book is packed with information about the country and the people, and yet a great deal remains to be told. The text is a little difficult to follow, because each page contains copious footnotes, which cannot be ignored, as they contain some of the most important and interesting information. There are twenty-five appendices, of which the most valuable deal with Buddhism, the races of Nepal, the flora and fauna, and the more important books and articles about the country. Nepal has recently been surveyed by Indian surveyors lent by the Government of India; and a skeleton map based on this survey is included in the first volume.

Mr. Landon died before the publication of his work. If he left any notes on Nepal which have not been included in it, it is to be hoped that they may be published, or at least be made available for geographers and others. Information about Nepal is rare and precious.

Midwifery in Great Britain.

The History of British Midwifery from 1650 to 1800: the Fitz-Patrick Lectures for 1927, delivered before the Royal College of Physicians of London. By Prof. Herbert R. Spencer. Pp. xxiv + 185 + 9 plates. (London: John Bale, Sons and Danielsson, Ltd., 1927.) 15*s*. net.

THIS volume, which is from the pen of an eminent London specialist, represents the first detailed account by an English writer of British obstetrics during the period 1650–1800. The book consists of four chapters, preceded by an introduction on the Chamberlen family, one member of which, probably Peter the Elder, invented what the author rightly designates as "the most beneficent of surgical instruments," the midwifery forceps.

The first chapter, which forms the bulk of the work, contains an account of the twenty-two chief British writers on midwifery during the period under consideration. Commencing with William Harvey, Dr. Spencer shows that this great man deserved the title given him by Aveling of 'father of British midwifery,' by reason of the wide view, scientific spirit, and conservative practice which were introduced by him into this department of

medicine, and have since remained the characteristic features of British obstetrics. Of Harvey's twenty-one successors described in this book, special mention must be made of Edmund Chapman, the first who publicly made known the forceps used by the Chamberlens in "An Essay for the Improvement of Midwifery" (1733); William Smellie (1697–1763), described by Fasbender as "one of the most important obstetricians of all times and all countries"; William Hunter, the author of a magnificent work on the gravid uterus; John Burton (1710–1771), who as author of the "Monasticon Eboracense" was better known as an antiquarian than as an obstetrician, though he served as the original of Sterne's Dr. Slop; John Leake (1729–1792), the founder of the Westminster Lying-in Hospital, and author of important works on puerperal fever, convulsions, and hæmorrhage; and Thomas Denman (1733–1815), the author of "The Introduction to the Practice of Midwifery," which is of value not only for the allusion to the work of his immediate predecessors and contemporaries, but also for the first account of induction of premature labour in cases of contracted pelvis, which, as Dr. Spencer points out, became a favourite operation in Great Britain long before it was accepted abroad.

In the second chapter, which is entitled "The Doctor and the Midwives," the author shows that before the forceps became generally known in 1733, the practice of midwifery in Great Britain was mainly in the hands of midwives, and the treatises on the subject were few in number and poor in quality. After the introduction of the forceps, midwifery was taken up by male practitioners, who thereby incurred the violent and scurrilous opposition of the midwives, which did not subside until the end of the eighteenth century.

The third chapter is devoted to an account of puerperal fever, with special reference to the work of Harvey, Gordon, White, and Denman. It is noteworthy, in view of later bacteriological discoveries, that the connexion of erysipelas with the disease, and the conveyance of infection by attendants, were observed by Gordon and Denman, and that Gordon prescribed washing of the attendants as a prophylactic measure. In the final chapter the contributions of British obstetricians during the seventeenth and eighteenth centuries are reviewed.

Dr. Spencer is to be warmly congratulated on his work, which shows a characteristic blend of fine scholarship and sympathetic estimation of his predecessors, with shrewd criticism and lively humour.

Our Bookshelf.

An Introduction to the Theory and Use of the Microscope. By Prof. C. R. Marshall and H. D. Griffith. Pp. viii + 90 + 3 plates. (London: George Routledge and Sons, Ltd., 1928.) 3*s.* 6*d.* net.

WHEN public interest in the curiosities of science was widespread, some fifty years ago, the possession of a microscope was a social necessity. The instrument to-day is no longer the popular plaything it formerly was. It has become a recognised part of the equipment essential to the progress of science and industry. Only the makers of microscopes will regret their useful restriction to the laboratory and the workshop, where the real function of the instrument can best be fulfilled.

According to the foreword, this rather brief "Introduction to the Theory and Use of the Microscope" has been prepared for the use of "students who require a microscope in their studies," and it is hoped by the authors that it will prove of value "as well to those amateur microscopists who wish to understand the principles upon which microscopy is based." In substance the book is founded on the lectures and practical work on microscopy forming part of the class work of medical physics in the University of Aberdeen.

Students who wish to obtain a working knowledge of this highly important instrument, and have no time for the study of a more elaborate treatise, will find this little book very useful. It provides a large amount of theoretical and practical information of the kind required by such readers in a small space, which might have been extended with advantage. In attempting in a few words to explain to beginners the principles of diffraction and resolution, the authors have assumed a difficult task. Abbe's diffraction theory can scarcely be discussed convincingly on the basis of 'scattering' and 'privileged directions.' Some of the statements made under the restriction of space may mislead the student rather than help him. "Outline pictures," for example, are described on the apparent assumption that rays caught by the lens reach the eye regardless of their obliquity.

At the end of the book there is included a useful chapter containing a selection of the more important fundamental formulæ and the principal physical proofs. There is an excellent index, which should enable the student to find at once the information he may desire. J. W. F.

Naval Electrical Manual, 1928. Vol. 1. By Prof. Cecil L. Fortescue. Published by Authority of the Lords Commissioners of the Admiralty. Pp. xiii + 812 + xl. (London: H.M. Stationery Office, 1928.) 12*s.* 6*d.* net.

THE Lords Commissioners of the Admiralty have decided that a standard work on the theory of electricity is required for the information and guidance of officers and men of H.M. fleet. For this purpose, therefore, the "Naval Electrical Manual," Vol. 1, 1928, has been prepared by Prof. Fortescue. An examination of the book shows that it begins by giving electric and magnetic laws and formulæ.

It then gives an introduction to direct current engineering. This is followed by a chapter entering very fully into the question of illumination. We next have alternating current engineering, including mercury rectifiers, and finally the practical theory of telegraphy and telephony.

Except in a few appendices, only elementary theorems of the calculus are used. Numerical examples are given at the ends of the chapters. The author writes very lucidly, and the theoretical matter given is not too difficult. His main object is to help the serious electrical student, and he has been successful. There is little to criticise anywhere in the book. The notation and nomenclature are practically always those adopted internationally. Where they differ from international usage there is good reason for the alteration. On p. 790 we do not see much use in having a special notation for the arithmetic mean of a harmonically varying quantity. With the possible exception of a few classical scholars, the readers of this work will have difficulty in understanding what the author means when he says that (H) eta is the English pronunciation of η, H, the seventh letter of the Greek alphabet. The book is cheap and should prove useful to many.

Optische Methoden der Chemie. Von Prof. Fritz Weigert. Pp. xvi + 632 + 16 Tafeln. (Leipzig: Akademische Verlagsgesellschaft, m.b.H., 1927.) 38 gold marks.

PROF. WEIGERT'S book is a guide to the use of optical methods in the study of chemical problems. It is therefore a practical rather than a theoretical book, and may be regarded as a specialised form of the "Hand- und Hilfsbuch zur Ausführung physikochemischer Messungen" which was produced by Ostwald many years ago, and of which a recent edition was reviewed in these columns in 1926. The similarity of type of the two books may also be inferred from the fact that Prof. Weigert has dedicated his own volume to Prof. Luther, now joint author of the "Handund Hilfsbuch."

The scope of Prof. Weigert's book is indicated clearly by the headings of the chapters, which deal with optical instruments, light sources, light filters, photographic processes, spectroscopy, photometry, spectrophotometry, colorimetry and nephelometry, colour measurement, energy measurements, photochemical measurements, microscopy and ultramicroscopy, the measurement of refraction, the analysis of polarised light, and the study of phosphorescence and fluorescence and the like. These chapters provide full information as to the instruments and processes that are available for each type of measurement. The descriptions are illustrated by 300 figures in the text, and by 16 plates at the end of the volume. There is also an appendix, in which the wave-lengths and intensities of the principal spectral lines are given.

The book is obviously useful, and can be commended without hesitation to all laboratories in which optical methods of investigation are used; and it should clearly find a place on the shelf on which books of numerical data are kept for immediate reference in the laboratory. T. M. L.

The Thirsty Earth: a Study in Irrigation. By E. H. Carrier. Pp. 222 + 8 plates. (London: Christophers, 1928.) 10*s.* 6*d.* net.

THIS book gives a general account of irrigation suited to the reader who wishes to know something of its effects and of the way it is done without going into too much technical detail. The author begins with a statement of the changes in climate which make land formerly humid become more arid: this is largely based on Ellsworth Huntington's conclusions, though reference is given to the views of Stein and of Burrard; he then gives some account of the methods of irrigation in the ancient world and in the modern world. The remainder of the book, and by far the largest part, is taken up with a description of the irrigated areas in Europe, America, Australia, and Africa, both north and south.

The author has collected much useful information especially geographical, and he gives numerous references which are particularly helpful, as this branch of the literature of the subject is not too well known. There is one notable omission, which should be remedied if a second edition is called for: there is no discussion of the relation of irrigation to malaria. Whenever irrigation is started in a dry region there is always the danger of malaria, and indeed this has probably been a factor in the break up of old irrigation communities. Some reference should have been made to the excellent work of Sir Malcolm Watson and those associated with him in the Malay Peninsula, and to the investigations of Prof. K. B. Williamson on the suitability of certain waters for the development of the mosquito.

Psychology of Infancy and Early Childhood. By Prof. Ada Hart Arlitt. (McGraw-Hill Euthenics Series.) Pp. xi + 228. (New York: McGraw-Hill Book Co. Inc.; London: McGraw-Hill Publishing Co., Ltd., 1928.) 10*s.* net.

THE recent formation of a Child Guidance Clinic under the Child Guidance Council, and with the approval of the London County Council, is an indication of the increasing importance attached to the mental care of the pre-school child in England. Miss Arlitt's book comes at a very opportune moment, and might with advantage be read by all parents who take a real interest in the mental welfare of their children. It is perhaps rather technical for the average reader, but there is a tremendous amount of straightforward material in the book which will point the way to train the pre-school child. If all mothers and fathers could be brought to carry out the training of the young children on the lines indicated, there would undoubtedly be a considerable lessening of the number of neurotics and psychoneurotics in England, and to a less extent a reduction in the number of cases of frank mental disorder of purely mental origin. The chapters on habit formation and on social attitudes in the preschool period and the development of personality strike us as the two most useful chapters in a well-written and evenly balanced book.

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.*]

Short Wave Echoes and the Aurora Borealis.

IN the issue of NATURE for Nov. 3 a short note by Prof. Carl Størmer appeared under this title. Prof. Størmer there described the observations made by him and Engineer Jørgen Hals, Oslo, of some remarkable echoes heard several seconds after the original signals—which were emitted from the short wave transmitter PCJJ ($\lambda = 31{\cdot}4$ metre) Hilversum specially for the experiment—reached the receiver at Oslo. These special signals were first sent in March 1928. Since then the experiment has been repeated over and over again, sometimes twice and often four times a week. A continuous watch for these echoes was also kept at Eindhoven, Holland, in two different places, either by myself or an assistant, or by both of us. We did not hear any of these long period echoes for several months.

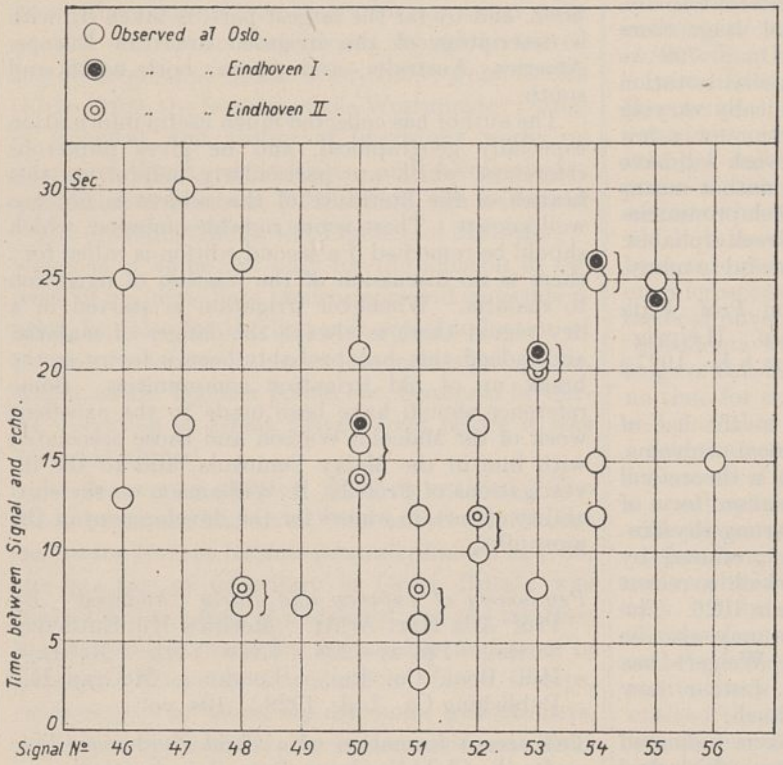

FIG. 1.

Then suddenly, on Oct. 11, I got a telegram from Prof. Størmer stating that very fine echoes had been heard that afternoon. Thereupon I immediately arranged the same night a series of test signals to be sent consisting of three short dots in rapid succession given every 30 seconds between 20 and 21 o'clock local time. I listened with my assistant to the 120 signals. Thirteen echoes were observed by both of us, the times between the signals and the echoes being: 8, 11, 15, 8, 13, 3, 8, 8, 8, 12, 15, 13, 8, 8 sec. The (radio) frequency of an echo was always exactly equal to the frequency of the signal, which fact could be easily verified as the signals were 'unmodulated,' and therefore the receiver was kept oscillating. The combination tone thus formed had exactly the same pitch, whether the original signal was received or the echo. The frequency of the local oscillator was slightly changed a few times after a signal was received, and then the echo came in causing a slightly varied pitch of the combination tone. When thereupon the receiver was left unaltered, the next real signal caused exactly the same pitch in the receiver as the last echo.

The echoes I heard were rather weak, and though their oscillation frequency could be easily identified to be the same as the frequency of the direct signals, the three dots of the original signal could not be recognised in the echo, the latter being of a blurred nature, except in the one case where the echo came in 3 seconds after the signal, when the three dots of the original signal were very plainly audible in the echo as well.

Thereupon I suggested to Prof. Størmer to count the signals in the further experiments, so that echoes heard in Oslo and in Eindhoven could perhaps be identified. Up to Oct. 24 neither in Oslo nor in Eindhoven were echoes heard. However, on that date, between 16 and 17 G.M.T., echoes were again observed both in Oslo and at two different places (3 km. apart) at Eindhoven. The frequencies of the two oscillating receivers at Eindhoven were adjusted at different sides of the carrier frequency of the signal in order to eliminate so far as possible the risk of regarding stray signals as echoes. Prof. Størmer kindly sent me the observations made that day at Oslo where 48 echoes were noted. Receiver No. 1 at Eindhoven (with two observers) noted 4 very weak echoes, and receiver No. 2 at Eindhoven registered 5 echoes. A part of the simultaneous observations are plotted in the accompanying graph (Fig. 1). The timing of the ◉ observations was done with a stop watch, while for the observations ◎ the second hand of an ordinary watch was used. As the echoes often lasted more than 1·5 sec., there is no doubt that some echoes were heard practically simultaneously in the three places referred to above. Therefore, though they are often difficult to observe, there is no doubt that the echoes really exist, as they have been heard by several observers at different places and a few times even simultaneously.

As an explanation of these echoes, Prof. Størmer in his letter suggests that the waves are reflected from the streams and surfaces of electrons which he has postulated as the result of his researches on the aurora borealis. According to this view, the waves would have to penetrate the Kennelly-Heaviside layer and travel distances outside the earth's atmosphere comparable with the distance to the moon.

Now fortunately wireless waves, even short ones, usually do *not* penetrate the Kennelly-Heaviside layer, otherwise long-distance communication would be impossible, and an alternative explanation for the occurrence of these long interval echoes may be found in the fact that the waves may penetrate *well into but not through* the layer. Usually, as Prof. Appleton has shown, the layer has a relatively well-marked

lower boundary against which waves travelling nearly vertically are sharply reflected. Now the apparent dielectric constant $\epsilon = 1 - \frac{4\pi^2 Ne^2}{m\omega^2}$ (where N is the density of electrons) diminishes with N, and even becomes zero for waves of 31·4 metre length and a density of *circa* 10^6 electrons per c.c. Moreover, with the dispersion law expressed by ϵ we easily obtain for the phase and group velocity: $v_{\text{phase}} \times v_{\text{group}} = c^2$, so that at the places where the electron density is near the critical one, the phase velocity becomes infinite, *but at the same time the group velocity approaches zero.* When it now happens that the relative variation of the electron density with height over a distance of a wave-length is small, then the waves may penetrate and soak well into the Kennelly-Heaviside layer and travel in regions where the group velocity is small; they will thereupon be reflected at the region where ϵ approaches zero.

It is obvious that in these circumstances a considerable time may elapse before the echo is received, though the waves have never travelled outside the earth's atmosphere. This point of view would also explain the curious echoes observed by A. Hoyt Taylor and L. C. Young (*Proc. Inst. Radio Eng.*, **16**, 561; 1928) which were distinct from the well-known round-the-world echoes (as was also remarked by Prof. Appleton at the last U.R.S.I. meeting). In fact, according to this explanation, any time-interval between signal and echo can be expected to occur, the phenomenon being wholly governed by the gradient of the electron density. This explanation fits in well with the fact that the time interval between signal and echo is extremely variable.

Our view is, therefore, that the group is compressed and 'bottled' for some time in those regions where the group velocity approaches zero.

BALTH. VAN DER POL.

Natuurkundig Laboratorium der
N. V. Philips' Gloeilampenfabrieken,
Eindhoven, Nov. 21.

IN connexion with Prof. Størmer's interesting letter on this subject in NATURE of Nov. 3, it may be of interest to inquire whether by purely terrestrial agencies such long temporal retardations of short wave signals may be explained. Abnormally long retardations of such signals, returned from the upper atmosphere, were first announced by A. H. Taylor and L. C. Young (*Proc. Inst. Radio Eng.*, vol. 16, May 1928), who, in experiments carried out between Rocky Point and Washington, obtained retardations corresponding to a distance of transit of 2900 km. to 10,000 km., although the great circle distance between the stations was only 420 km. In discussing these experiments in a paper at the Brussels meeting of the Union Radio Scientifique Internationale in September last, it was pointed out that wireless waves, meeting the ionised layer at vertical incidence, would travel upwards until they were 'reflected' at a point where the group velocity was reduced to zero, and that if the ionisation gradient in this region was not large, the waves might be appreciably retarded before and after reaching the critical value of ionisation. Put quantitatively, the retardation of any signal sent up from the ground and received there again is $\frac{1}{c}\int \frac{ds}{\mu}$ (where c is the velocity of radiation *in vacuo*, ds an element of path, and μ the refractive index), and this quantity may greatly exceed $\frac{1}{c}\int ds$ if μ is very small for an appreciable part of the path.

Now the retardations observed by Engineer Hals and Prof. Størmer are much longer than those observed by Taylor and Young, but that intermediate values are sometimes obtained is evidenced by some work carried out in this laboratory by Mr. R. L. A. Borrow, who has succeeded in getting photographic registration of the echoes from Eindhoven (PCJJ) corresponding to retardations of 1 sec. The question arises whether waves of 30 metres can remain travelling with a low group velocity in the ionised layer for such a long period as 10 sec. and yet be of appreciable intensity on arriving again at the ground. As possible paths we might consider the waves as travelling round the earth in the ionised layer or as travelling horizontally into the sunset (or sunrise) discontinuity in the layer and being reflected there. If we consider the group velocity to be small, the calculation of the attenuation experienced by the waves turns out to be simple, the signal intensity being reduced to $e^{-ft/2}$ of its initial value, where f is the frequency of electron collisions with air molecules and t is the time of retardation in the layer. If we assume commonly accepted values for f at 250 km. above the earth's surface, a signal of 10 sec. retardation would be e^{-5009} of its original value, while at 400 km. the corresponding figure would be e^{-50}. Thus, unless the ordinarily accepted values of f are considerably in error, the attenuation of signals retarded by travelling at these heights would be very great. But if there were sufficient ionisation at heights of 600 km. or more, it is certain that retardation without much absorption could take place, although our inadequate knowledge of the values of f for such regions precludes a more quantitative statement.

There is, however, another possibility. If we think of the ionised layer as a 'reflecting' shell, the waves sent out by an emitting station will converge to some point near the Antipodes, which, in turn, may be regarded as a source from which another set of waves emerges. Now it is known that conditions in the layer alter very rapidly, so that the points to which the waves converge every ½ sec. (the time of a circumferential journey) will vary rapidly. It thus may be some seconds before a particularly loud repetition of a signal reaches a particular region of the earth.

In conclusion, it may be pointed out that information relating to the question of terrestrial or extra-terrestrial 'reflection' may be obtained by testing whether waves of 30 metres, meeting the layer at approximately vertical incidence, actually penetrate it. Experiments to decide this point for slightly longer waves have been carried out in transmissions between the National Physical Laboratory and this laboratory as part of the programme of the Radio Research Board of the Department of Scientific and Industrial Research, and it is hoped that similar tests may be made on 30 metres shortly.

E. V. APPLETON.

Wheatstone Laboratory,
King's College, W.C.2,
Nov. 27.

The Hydroxyl Radical in Flames.

THE evidence in favour of the view that the hydroxyl radical is present in flames has been summarised recently by Bonhoeffer and Haber (*Z. Phys. Chem.*, **137**, 263; 1928). There is no doubt that this radical is the emitter of the 3064 A. band, present in the spectra of hydrogen flames, and Hulthén and Zumstein, and Bonhoeffer have shown that this band occurs in absorption when water vapour is heated to high temperatures. The discovery of the existence of this radical in flames has an important bearing on the development of our knowledge of mechanisms of the

reactions occurring in hydrogen and hydrocarbon flames.

The infra-red radiation from hydrogen flames is usually ascribed to the water molecule, on the grounds that so many of the emission bands of water vapour (600° C.) and absorption bands of water vapour (700° C.) agree with the emission bands from the flame (Paschen, *Ann. der Phys. und Chem.* **52**, 214; 1894). If, however, the hydroxyl radical is present in water vapour at high temperatures, then some of the infra-red emission from the flame may be due to it and not to water vapour. Confirmation of this idea is obtained from a study of measurements of the total radiation (mainly infra-red) from flames of hydrogen and oxygen with varying compositions.

The radiation from this flame has been measured by the methods described previously (Garner and Johnson, *Jour. Chem. Soc.*, 280; 1928). The mixed

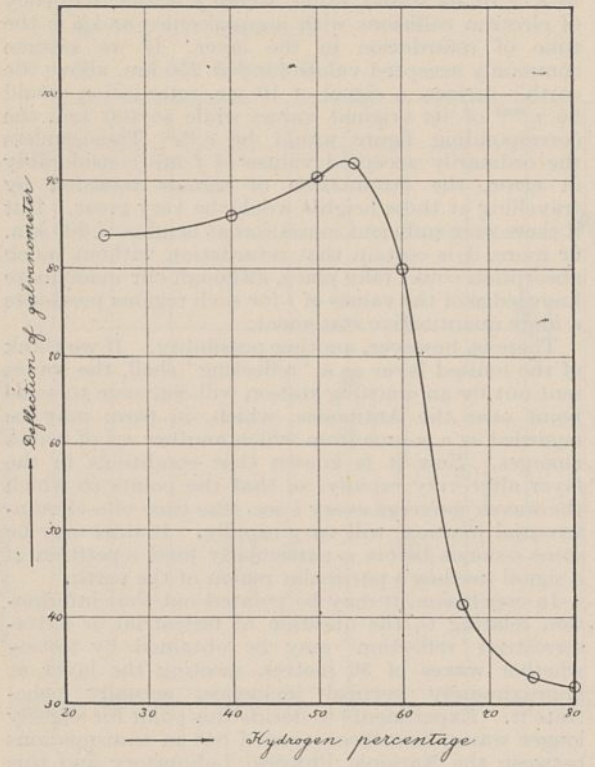

FIG. 1.

gases were burnt in a cylindrical bomb 40 cm. long and 2·5 cm. diameter, at an initial pressure of 1 atmosphere. The radiation emitted through a fluorite window was measured by means of a Moll thermopile and a Downing galvanometer. The results are shown for a number of mixtures of oxygen and hydrogen in Fig. 1, where the galvanometer deflections are plotted against percentage composition. The deflections have been corrected so that in all cases they correspond to the radiation from the same quantity of burnt gas. The results are of a preliminary character, and the position of the maximum is not known accurately.

The maximum emission of radiation does not occur for the mixture of two volumes of hydrogen with one of oxygen, which would be expected, since this mixture gives the highest flame temperature. It occurs for the mixture $H_2 + O_2$ very nearly, which indicates that the hydroxyl radical may be responsible for the emission of part of the radiation from the hydrogen flame.

On this assumption it is possible to explain the above curve. If the hydroxyl radical is produced as a first stage in the reaction between H_2 and O_2,

$$H_2 + O_2 \longrightarrow 2OH,$$

and it emits a fraction of the energy of chemical change as chemiluminescence, then the quantity of radiation emitted will depend on its average duration of life. The hydroxyl radical will undergo reaction in the presence of hydrogen to give water at a rate which will depend on the hydrogen concentration. Thus, excess hydrogen will diminish average life of the radical. Excess oxygen would be unlikely to produce such a marked effect as hydrogen, and the decrease on the oxygen side may be due to inelastic collisions, $OH' + O_2 \longrightarrow OH + O'_2$.

K. TAWADA.
W. E. GARNER.

The University, Bristol.

Molecular Hydrogen in Sunspots.

WHILE carrying out research on the elements of rare earths in sunspots, I happened to notice some lines in a photograph taken at the Arcetri solar tower by Prof. G. Abetti which, so far as I know, have not been hitherto identified. These lines, which were relatively intense in the spots, and very faint, or entirely absent in the photosphere, may be attributed to the secondary spectrum of hydrogen, that is, to the molecular spectrum.

The photograph was taken in the second order with dispersion 1 A. = 1 mm., and comprised the red portion of the spectrum between λ5900 to λ6200, one of the regions where partial bands of striking intensity appear in the secondary spectrum. It will be noted that the region photographed does not include bands of calcium hydride, which covers a large portion of the spot spectrum with very numerous and very crowded lines, rendering it impossible to identify, with any certainty, the lines of the secondary spectrum.

Since experimental data and thermodynamical considerations do not conflict with the presence of molecular hydrogen under the conditions of temperature and pressure prevailing in the spots (4000° K. and 10^{-2} or 10^{-3} atm.), I resolved to compare a wider region of the spot spectrum with the secondary hydrogen spectrum to ascertain whether coincidence between the two spectra might strengthen the hypothesis of the presence of molecular hydrogen.

For this purpose I made use of the recent and accurate measurements of the secondary spectrum of hydrogen carried out by H. G. Gale, G. S. Monk, and K. O. Lee (*Astrophys. Jour.*, **67**, 89; 1928), and of a large scale map (0·25 A. = 1 mm.) of the sunspot spectrum taken at Mt. Wilson, a copy of which is in the Arcetri Observatory. This map, prepared by Ellerman at the great solar tower, using the polarising system for the study of magnetic fields, has not yet been published. The comparison, which was extended to the region between λ6400 and λ4450, shows numerous coincidences with a maximum error of about ± 0·03 A. in the I. A. system.

I noticed, further, that all the lines which are presumed to be those of the secondary spectrum of hydrogen show no trace of the Zeeman effect as is seen in the map. In fact, they behave exactly as do the lines of calcium hydride, magnesium hydride, etc., also present in the spots. This means that molecular hydrogen can be present in the higher regions of a sunspot, beyond the influence of the magnetic field, where the possibility of the existence, at least of certain molecules, is positively assured.

GIORGIO PICCARDI.

Istituto di Chimica Generale
della R. Università, Via Gino Capponi 3,
Firenze, Italy.

International Commission on Zoological Nomenclature.

THE undersigned has the honour to invite the attention of the zoological profession to the fact that Opinions 98 to 104 have been published by the Smithsonian Institution (*Smithsonian Miscellaneous Collections*, vol. 73, No. 5). The summaries read as follows :

Opinion 98.—Rigidly construed, Brauer and Bergenstamm (1889 to 1894) did not fix the types for the older generic names, except in the cases where they distinctly state that the species mentioned is the type of the genus.

Opinion 99.—*Entamœba* 1895, with *blattæ* as type by subsequent (1912) designation, is absolute synonym of *Endamœba* Leidy, 1879*a*, p. 300, type *blattæ*, and invalidates *Entamœba* 1895, type by subsequent (1913) designation *hominis* = *coli*.

Opinion 100.—Under suspension of the rules the genotype of *Spirifer* Sowerby, 1816, is fixed as *Anomia striata* Martin, and the genotype of *Syringothyris* Winchell, 1863, is fixed as *Syringothyris typa* Winchell (= *Spirifer carteri* Hall).

Opinion 101.—The technical Latin designations used by Danilewsky, 1891, *Annales de l'Institut Pasteur*, vol. 5 (12), pp. 758-782, are not in harmony with the International Rules of Zoological Nomenclature, and are therefore not subject to citation or the law of priority on basis of said publication.

Opinion 102.—A generic name (example, *Proteocephalus*, 1858) is not invalidated by the earlier publication of the identical or a similar name of higher rank (example, *Proteocephala*, 1828). If *Tœnia ambigua* (tod. of *Proteocephalus*, 1858) is congeneric with *ocellata* (tsd. of *Ichthyotœnia*, 1894), *Ichthyotœnia* is a subjective synonym of *Proteocephalus*.

Opinion 103.—The type of *Grus* Pallas, 1767, is *Ardea grus* Linn., 1758, by absolute tautonymy. *Grus* is hereby placed in the official list of generic names.

Opinion 104.—The following 57 generic names, with type species cited, are hereby placed in the official list of generic names :

Protozoa : *Bursaria*, *Eimeria*, *Laverania*, *Plasmodium*, *Sarcocystis* ; Cestoda : *Ligula* ; Nematoda : *Filaria*, *Heterodera*, *Rhabditis*, *Strongylus*, *Syngamus* ; Oligochæta : *Enchytræus* ; Hirudinea : *Hœmadipsa*, *Limnatis* ; Crustacea : *Armadillidium*, *Astacus*, *Cancer*, *Diaptomus*, *Gammarus*, *Homarus*, *Nephrops*, *Oniscus*, *Pandalus*, *Penœus*, *Porcellio* ; Xiphosura : *Limulus* ; Scorpionidea : *Scorpio* ; Araneæ seu Araneida : *Aviculariа*, *Dendryphantes*, *Dysdera*, *Latrodectus*, *Segestria* ; Acarina : *Cheyletus*, *Chorioptes*, *Demodex*, *Dermanyssus*, *Glyciphagus*, *Polydesmus*, *Psoroptes*, *Rhizoglyphus*, *Trombidium* ; Thysanura : *Lepisma* ; Collembola : *Podura* ; Orthoptera : *Blatta*, *Ectobius*, *Gryllus*, *Periplaneta* ; Anoplura : *Pediculus*, *Phthirus* ; Hemiptera : *Anthocoris*, *Nabis*, *Notonecta*, *Reduvius*, *Triatoma* ; Dermaptera : *Forficula* ; Suctoria s. Siphonaptera s. Aphaniptera : *Pulex* ; Mammalia : *Cercopithecus*.

C. W. STILES
(Secretary to the International Commission on Zoological Nomenclature).
Washington, D.C.

A Psychological Analysis of Radicalism.

HAVING recently travelled round the world, and come in contact with various types of radicalism, especially in Russia and India, I have thought it possible that some form of analysis might facilitate clearer thinking. It is possible to recognise three types :

(1) Emotional radicalism.
(2) Mechanical radicalism.
(3) Rational radicalism.

By radicalism we mean the attitude of seeking or promoting radical or fundamental reforms. In the first type we witness a desire for reform, without any sufficiently considered programme. Formerly we had a party in the United States called the Populist Party. It had considerable success at first, as a party of justifiable indignation or protest, but having no well-reasoned plans it became extinct. Some one wittily defined a populist as " a man who doesn't know what he wants, but wants it damned bad." The second type is built on a theory or dogma, and is well illustrated by Marxian or Leninian socialism. In Russia, furious debates arise over the question, What would Marx, or what would Lenin, have said or done in existing circumstances ? The third type, to which many scientific men belong, is pragmatic, and depends upon the close and constant study of all the factors involved.

The first and third types involve more thought than the second ; but in the first the attitude is primarily subjective, in the third more objective. Rational radicalism, while abundantly distinct from the other two, partakes in some measure of their qualities. Thus it necessarily has to be based on fixed principles, the laws of Nature ; and it gets its driving force from those emotions which come from a sense of human values, regardless of mechanistic or cosmic considerations. Emotional radicalism is the easiest, and may even be said to be displayed by children when they resent discipline. Rational radicalism is the hardest, and at different times may be the most conservative or cautious, or the most progressive and venturesome. Its programme varies with circumstances, and with the completeness of our knowledge and accuracy of our judgments.

T. D. A. COCKERELL.

University of Colorado,
Boulder, Colorado, Oct. 30.

Long Wave Radio Reception and Atmospheric Ozone.

I AGREE with Dr. Dobson (NATURE, Nov. 10, p. 725) that the relation that has been found between Bangalore observations on Madras and the ozone values for north-western Europe requires extended observations for confirmation. Far from being an assertion of an established relation, my letter was intended to direct attention to the probable connexion as shown by the correlation figure of $0{\cdot}88 \pm 0{\cdot}023$.

Dr. Dobson is no doubt aware of the periodic variations in radio field intensity as well ; this has been shown by Austin, Mesny, and other observers. The Bangalore observations on Madras, too, indicate the same. In addition to the seasonal variations noted by every observer, we have also an annual increase in intensity, specially marked in the observations on Bordeaux, at Meudon, and at Washington, with fairly definite similar variations in sunspots (Wolfer's figures).

In the present case, considering the great distance and the period of comparison—six months—the relation found was so unexpected that a common cause for the variations suggested itself ; if true, it would mean that the variations in ozone values would not partake of a strictly local character.

In view, however, of Dr. Dobson's statement that in lower latitudes the annual variations of ozone are comparatively small, it would be interesting to know if there is any similarity in the variations at low latitudes, such as they exist. The actual ozone value

will no doubt, as Dr. Dobson says, depend on the locality itself.

While taking the greatest care in the examination of observations, any probable connexion should not be overlooked. K. SREENIVASAN.

643 Fulham Road, London, S.W.6.

Higher Hydrocarbons from Methane.

MESSRS. Stanley and Nash, in their interesting letter on the production of higher hydrocarbons from methane, NATURE, Nov. 10, p. 725 (cf. also Prof. Wheeler's comments, Nov. 17, p. 773), have inquired whether the carbon which is formed during the thermal decomposition of methane could combine with hydrogen to form gaseous hydrocarbons.

In attempting to extend the methods of measuring the area of catalytically active surfaces to non-metallic surfaces (*Proc. Roy. Soc.*, A. vol. 119, p. 196; 1928) I have studied the action of a graphite surface supported on china clay rods on methane, ethylene, acetylene, propylene, and hydrogen. The graphite film was heated by an electric current to temperatures varying from 800° C. to 1200° C., estimated by a disappearing wire optical pyrometer. In the case of these hydrocarbons, gas carbon was always deposited on the exterior of the graphite film. A good deposit of carbon was also found in the pores of the china clay rods, so much so that the initially white rod was turned black throughout, and the rate of diffusion of gas from the centre of the rod to the outside was cut down ten times by heating for 5 min. at 1100° C. in propylene.

During the experiments with methane and propylene, these gases were suddenly removed and replaced by pressures of 5, 10, 20, and 50 cm. of pure hydrogen. In only one case was there any change in the pressure of the hydrogen introduced, this being a slight increase in pressure of 0·15 cm. mercury, and fully accounted for by the fall in the barometric pressure during the experiment.

The conclusion seems evident that under these conditions the carbon deposited is incapable of combining with hydrogen at any appreciable speed. Whether carbon could combine with hydrogen at the instant of deposition seems doubtful.

F. HURN CONSTABLE.

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Rotation of Molecules induced by Light.

IN an earlier note to NATURE (Aug. 25, p. 278) we ventured to suggest that the nebulosity or wings which accompany the original lines of the mercury arc after scattering in benzene liquid, are the effect of those collisions of the incident light-quanta with the molecules which result in a change of their rotational state. At the present time we are not very clear as to the conditions under which a spin may be set up in the molecule when it collides with a light-quantum. It appears, however, reasonable to suppose that the probability of such spin being induced should depend, among other factors, on the degree of optical anisotropy of the molecule.

In agreement with this supposition it is found that while the aromatic compounds such as benzene, toluene, pyridine, etc., which have a strong optical anisotropy, exhibit the wings of the scattered lines in a striking manner, the aliphatic compounds such as carbon tetrachloride, ether, alcohol, etc., which are much more nearly isotropic optically, exhibit the effect only very feebly. A further confirmation of this idea is furnished by photographs of the scattered spectrum from carbon disulphide taken by Mr. P. V. Krishnamurthy in our laboratory.

It is well known that the carbon disulphide molecule has a high degree of optical anisotropy. The photographs show, as expected, besides some displaced lines, also strong wings accompanying the original lines of the mercury arc. Incidentally, we may mention that the wings appear to consist of unpolarised light.

C. V. RAMAN.
K. S. KRISHNAN.

210 Bowbazar Street,
Calcutta, Oct. 18.

The Chromomeres of *Lilium*.

IN specially well-fixed preparations of the pachyphase (pachytene stage) of *Lilium*, stained with iron-brazilin, the following phenomena were observed:

The homologous chromomeres of the two conjugated threads are split, and the two halves of each (chromioles) remain in contact (as Gelei also found; *Archiv f. Zellforsch.*, **22**; 1921).

These two pairs of chromioles become joined (if small) by transverse threads (as Gelei also observed), and if large by lateral fusion.

Rather often both the sister chromioles of one homologue do not unite with their partners, but only one unites. Thus a transverse V is formed. Sometimes a number of such V's follow one another in the thread.

In a small percentage of cases the two sister chromioles of one chromosome are not equal to the homologous pair, but are much smaller.

In a somewhat larger number of cases, both homologous chromomeres are markedly smaller than the general size (although this is variable). They are connected by two transverse threads. This double connexion is an indication that they are divided, which is not otherwise visible.

In quite a small percentage of cases only one homologous chromomere is visible. It is large and well stained, sometimes showing indications of division into two. On the other side there is a blank, and there are no transverse threads.

JOHN BELLING.

Carnegie Institution of Washington,
Department of Genetics,
Cold Spring Harbor, New York, U.S.A., Oct. 1.

The Electrical Conductivity of Metals.

IN the recent theories of metallic conduction the exchange of electrons between neighbouring atoms has perhaps not been sufficiently considered. The new quantum mechanics as applied to molecules has shown that, for distances of the order of those which separate the atoms in a crystal lattice, electrons go over from one atom to the other more than 10^{10} times per sec. Roughly, this frequency of interchange is a function of the nuclear charge, of the number of the electrons per atom, as well as of the average distance of the atomic neighbours (number of atoms per cell; temperature). These variables have been shown by K. F. Herzfeld (*Phys. Review*, vol. 29, p. 701; 1927) to be decisive in making an element a metallic conductor. An applied external field will favour the rate of exchange with the neighbours lying in the direction of the electric field, and cause a flow of electrons in one direction. For certain appropriate values of the atomic properties, super-conductivity may result.

By admitting this sharing of electrons it is possible to account for the magnetic properties of single metal crystals of zinc and cadmium, which have recently been investigated at my suggestion (*Proc. Roy. Society*, in course of publication; NATURE, Mar. 10, 1928.) RICHARD RUEDY.

Toronto.

Production and Properties of High-frequency Radiation.[1]

By Sir ERNEST RUTHERFORD, O.M., Pres. R.S.

IN my address last year I referred to recent advances in the production of very high voltages for technical purposes, and the application of these voltages to highly exhausted tubes in order to obtain a copious supply of high-speed electrons and atoms and high-frequency radiation. It is of interest to note how rapidly in recent years our ideas have widened as to the possibilities of production of very high-frequency radiation of the X-ray type, both by artificial and natural processes.

On the quantum theory, the energy associated with a quantum of radiation of frequency ν is given by $h\nu$, where h is the well-known constant of Planck. When swift electrons impinge on matter, radiation of an X-ray type is generated over a wide range of frequencies, and it has been verified experimentally that the maximum frequency of the radiation obtainable in this way is limited by the relation $E = h\nu$, where E is the energy of motion of the electron, a result in accordance with energy considerations.

For purposes of discussion, it is very convenient to express the energy of a quantum not in ergs but in terms of a potential difference in volts, through which an electron must fall to acquire an equal energy. Expressed in this way, the energy of a quantum of green light corresponds to 2 electron-volts, or 2 volts for brevity. Before the advent of X-rays the highest frequencies examined were confined to the ultra-violet part of the light spectrum, corresponding to less than 10 volts. Following the discovery of X-rays and the application of methods for determining their frequency, we have been enabled to study radiations over a wide range of individual energy, varying from a few hundred volts to 300,000 volts or more. By the use of special gratings and other methods, the gap in frequency between ordinary ultra-violet light and soft X-rays has been bridged in the last few years. There appears to be no limit to the maximum frequency that can be obtained by the bombardment of matter with electrons, except the practical difficulty of obtaining streams of the requisite high-velocity electrons. In some recent experiments in the Institute of Technology, Pasadena, about 1 million volts has been successfully applied for a short time to a suitably designed X-ray tube. It is stated that the X-rays obtained were of such intensity and penetrating power that they could easily be observed by the luminosity on a phosphorescent screen 100 feet away.

So far our experiments in this direction have been limited to about 1 million volts, and we have not yet been able to produce X-rays in the laboratory of penetrating power equal to that shown by the γ-rays spontaneously emitted by radioactive bodies. The highest frequency observed in their transformations corresponds to between 3 and 4 million volts. Some recent experiments indicate that the γ-rays which accompany the weak radioactivity of potassium are of still greater penetrating power than the rays from radium, but no definite estimate of the maximum frequency has so far been made.

There is in addition another general method of estimating the frequency of radiation that may arise in certain fundamental atomic processes of a simple type. According to modern views, energy and mass are closely connected, and the relation between the energy E resident in a mass m is given by the well-known equation of Einstein, $E = mc^2$, where c is the velocity of light. According to this view, if any system decreases in mass by internal rearrangement, the total energy lost in the process is given by the product of the change of mass multiplied by c^2. If this energy is emitted in the form of a radiation of one definite frequency ν, then $h\nu = c^2 dm$, where dm is the accompanying change of mass of the system. On account of the very small change of mass even for a large emission of energy, it is difficult to give a direct experimental proof of this relation, but there seems to be little doubt of its general validity. Even for the radioactive bodies which in their successive transformations spontaneously emit a very large amount of energy per atom, in the form of α-, β- and γ-rays, the effect to be expected is small and difficult to measure. The atom of uranium of mass about 238, after successive transformations involving the loss of eight α-particles, changes into an isotope of lead of mass about 206. It is to be anticipated that, if the methods of positive ray analysis could be applied to these elements, the difference between the atomic masses of uranium and the resulting lead would include not only the mass of 8 helium nuclei in the free state, but also about 0·05 unit of atomic mass, corresponding to the total emission of energy of about 46 million electron-volts per disintegrating atom of uranium. This difference —about 1 in 4000—should be just detectable by the methods employed by Aston in his study of isotopes. Similarly the change of mass in each transformation can be deduced if the energy released during the process is known experimentally.

We shall now consider the application of these ideas to certain nuclear processes. It is now generally accepted that the nuclei of all the elements are composed of protons (hydrogen nuclei) and electrons. While it is of course difficult to give a definite proof of this hypothesis, we know that it is strongly supported by the work of Aston on the atomic masses of the isotopes of the elements and by the experiments on the liberation of protons from certain light elements when bombarded by swift α-particles. It is generally supposed that the helium nucleus is composed of a close combination of four protons and two electrons. The mass of the helium atom is 4·00216 (O = 16), while the mass of four hydrogen atoms in the free state is $4 \times 1{\cdot}00778$. There is in consequence a loss of

[1] From the presidential address delivered at the anniversary meeting of the Royal Society on Nov. 30.

mass of 0·029 in the formation of the helium atom. This indicates a loss of energy of 27 million electron-volts in the process of building a helium nucleus from free protons and electrons. If it be possible to imagine that in some way this energy is emitted catastrophically, in a single quantum of radiation, the energy of the quantum would correspond to 27 million volts. The energy emitted per atom is thus very large, and it has been suggested by Eddington and others that the formation of helium from hydrogen nuclei and electrons may be one of the sources of the energy radiation from the stars.

In a similar way the total energy emitted during the formation of any atom of known mass from free protons and electrons may be estimated. Since the proton in a free state has a mass 1·0073, and a mass about 1·000 in the average nuclear combination, the energy released per proton is about 7 million volts. For example, the atomic weight of the most abundant isotope of mercury (atomic number 80) is 200·016, and this presumably contains 200 protons, of mass nearly unity, and 120 electrons. Disregarding the small mass due to the electrons, we may conclude that the total energy emitted during the formation of a mercury atom from free protons and electrons is about 1400 million electron volts.

When we consider the extreme complication of such a heavy nucleus and the number of its component parts, it is difficult to believe that this emission of energy can take place in one single catastrophic act. It is so much more likely that the energy is emitted in a step-by-step process during the organisation of the nucleus. Except for light atoms, where the nuclear structure is simple, it is to be expected that the radiation of energy from all complex nuclei would occur in successive stages.

On the other hand, there is one possibility to consider, which was first put forward by Jeans to account for the long lives of the hot stars. He supposes that even the protons and electrons are not indestructible, but may under unknown conditions be transformed into radiation. The total internal energy of the electron is about 500,000 volts, but of the proton 1840 times greater, or about 940 million volts. If we suppose the proton and electron to disappear together in the form of radiation, there must be an enormous liberation of energy. If this energy be emitted in a single quantum, we should expect to obtain a γ-radiation corresponding to about 940 million volts. Such a hypothesis is admittedly of a very speculative nature and may be very difficult of direct proof or disproof.

Apart from the radioactive bodies we have no definite experimental evidence of the emission of penetrating radiations, either in the formation of atoms or destruction of protons, and it may be that the processes considered do not take place under the conditions of our experiments on the earth. On the other hand, the long life of the hot stars indicated by general astronomical evidence does seem to demand some such process or processes in which the liberation of energy is enormous compared with the mass involved.

It is thus of very great interest to examine whether any direct experimental evidence can be obtained of the existence of such extraordinarily energetic γ-rays. This interest is heightened by the experiments in recent years which have shown the existence of an extremely penetrating type of radiation, sometimes called the 'cosmic' rays, in our atmosphere—a radiation much more penetrating than the γ-rays from the radioactive bodies. This radiation has been detected and measured by the small ionisation produced in a closed electroscope. The initial observations were made by Hess and by Kolhörster, and we owe much to the admirable experiments of Millikan and Cameron, who have carefully examined the absorption of this radiation by the water of mountain lakes, which are practically devoid of ordinary radioactive matter.

It is clear from these experiments that the radiation is complex in character, and that there are present radiations which are able to pass through 17 metres of water for a reduction of intensity to one-half value. It is natural to suppose that this radiation is of a γ-ray type, but it should be borne in mind that the effects so far observed would be equally explicable if the radiations consisted not of high-frequency γ-rays, but of high-energy electrons entering our atmosphere.

Assuming, however, that the radiation is of the γ-ray type, it is necessary to consider the factors that determine the absorption of such a radiation by matter. During the past twenty years the problem of the nature of the absorption of X-rays and γ-rays by matter has been the subject of detailed investigations, and there is now a general consensus of opinion of the main features of the processes involved. In the case of the heavier elements, the absorption of ordinary X-rays is mainly due to the interaction between the radiation and the electrons in the atom, whereby the energy of the quantum of radiation is transferred to the electron. This is generally known as the 'photoelectric' effect. In addition, there is a relatively small loss of energy due to the scattering of the incident radiation by the electrons; but in general, except for very high-frequency X-rays and light elements, the absorption due to the photoelectric effect predominates. The case is quite different when we deal with penetrating γ-rays, where the loss of energy due to the process of scattering becomes relatively much more important, and for radiation of the order of 100 million volts almost completely governs the absorption.

The main features of this scattering, known as the Compton effect, are now well understood. There is an occasional interaction between the quantum of radiation and the electron in an atom, whereby the radiation is scattered and the electron set in motion. The scattered radiation is always of lower frequency than the incident radiation, the difference depending on the angle of scattering. In this type of encounter between radiation and an electron, both momentum and energy are conserved, and consequently the energy given to the electron depends on the nature of the encounter and thus on the angle of scattering of the radiation. The

essential correctness of this theory has been verified by several distinct methods.

When a pure radiation of definite frequency is passed through matter, there always remains some transmitted radiation which has not been transformed, but mixed with it are degraded radiations of much lower frequency and swift electrons set in motion by the process of scattering. The ionisation observed in a closed vessel is probably mainly due to the electrons liberated by scattering in the medium and the walls of the containing vessel.

Assuming that the laws of the Compton process of scattering are valid for high-frequency radiation, there still remains the difficulty of estimating the probability of such scattering encounters, for on this probability depends the actual magnitude of the absorption coefficient. Different methods of calculating this probability have been given by A. H. Compton, Dirac, and recently by Klein and Nishina. The theory of Compton is based mainly on classical analogies, and that of Dirac on the earlier quantum mechanics. Recently the problem has been attacked again by Klein and Nishina (NATURE, Sept. 15, 1928), using the later relativistic form of wave-mechanics formulated by Dirac. The calculated absorption coefficients for high-frequency radiations differ materially from one another on these three theories, and in particular the theory of Klein and Nishina gives a greater absorption coefficient for a given high-frequency radiation. For radiations of individual energy more than 100 million volts, the coefficient is about five times greater than that given by the formula of Dirac.

Unfortunately, the experimental evidence available from a study of the absorption of the most penetrating γ-rays from radioactive bodies is not complete enough to give a definite test of the validity of these theories. However, Mr. Gray, of the Cavendish Laboratory, who has made a careful examination of existing data on the absorption of γ-rays, informs me that the evidence as a whole is more in accord with the theory of Klein and Nishina than with the earlier theories of Compton and Dirac. It is evident, however, that in view of the importance of the question, a careful determination is required of the absorption and scattering of γ-rays of as definite frequency as possible in order to distinguish between the various theories.

It is of interest to note that the absorption coefficient of the most penetrating type of radiation deduced by Millikan and Cameron from their experiments is in excellent accord with that to be expected on the Klein-Nishina theory for a quantum of energy 940 million volts—the energy demanded for the transformation of the internal energy of the proton into radiation. Although this agreement is suggestive, our theories of absorption are at present too uncertain to place much weight upon it. Even if subsequent experiment should prove the correctness of an absorption formula within a certain range of frequency corresponding to the γ-rays, there would still be the need of extrapolating the formula over a very wide range, say from quantum energies of 3 million volts to 1000 million volts, to include the ultra-penetrating rays observed in our atmosphere.

In addition, there are a number of new factors which may have to be taken into consideration when we are dealing with the passage of very high-frequency radiation through matter. In the ordinary theories, the scattering of the radiation is supposed to be confined to the extra-nuclear electrons, but if we are dealing with a quantum of energy corresponding to the order of 100 million volts, it is not unlikely that the nuclear electrons may be effective in scattering as well as the outer electrons. Such an effect is to be expected if the energy of the quantum is large compared with the energy required to release an electron from the nucleus. In addition there is always the possibility and even the probability that such energetic radiations or the swift electrons liberated by them may be able occasionally to disintegrate the nucleus of the atom in their path.

For all these reasons, it is evident that much more information is required before we can draw any but tentative conclusions as to the nature of the penetrating radiations in our atmosphere. So far, experiments have been mainly confined to measuring the ionisation produced in a sealed electroscope. Further experiments are required which will give us definite indication of the energy of the swift electrons present in the atmosphere, for this will give us valuable information on the maximum frequency of the radiation present, quite independently of the exact accuracy of our theories of absorption.

Continued observations made in a Wilson expansion chamber should throw much light on the nature of the particles which produce the ionisation in a closed vessel, and with the addition of a magnetic field of sufficient intensity the curvature of the tracks of β-rays should enable us to determine their individual energy. Experiments of an analogous kind have already been made with an expansion chamber by Skobelzyn, in order to determine the relative intensities of the main γ-rays emitted by radium C. In the course of these experiments he has observed on several occasions the trails of very energetic β-particles, probably arising from the ultra-penetrating radiation in our atmosphere. During the present year Prof. Hans Geiger has developed a modified form of β-ray counter which records each β-particle entering a vessel of considerable volume in any direction. This new method is so delicate that it may prove very useful in counting and even recording the number of β-particles produced by the penetrating radiation.

While it is to be hoped that in the years to come we may have available for study in our laboratories swifter β-rays and higher frequency radiation than we have to-day, we can scarcely hope in the near future to produce artificially radiations, atoms, and electrons which have an individual energy of the order of 100 million to 1000 million volts, such as are present in our atmosphere.

It is thus of great interest and importance to use

every promising method of attack to throw light on the nature and origin of these penetrating radiations and the effects arising in their transmission through matter. The magnitude of the effects to be observed is small and not easy to measure with accuracy; but with the ever-increasing delicacy of methods of attack we may hope to gain much further information. The study of these extraordinarily penetrating radiations is not only of great interest in itself, but also for its promise of throwing new light on fundamental processes in our universe connected with the building up and destruction of atoms. It may take many years of faithful experiment before the evidence is sufficient to test the correctness of the numerous interesting speculations that have been advanced to account for the origin and nature of these radiations.

Copper in Antiquity.

ON more than one occasion attention has been directed to the work of the British Association Research Committee which is investigating the sources of Early Sumerian copper. The interim report which was presented at the recent Glasgow meeting of the Association is of exceptional interest. It embodies a report by Prof. C. H. Desch which would appear to point to a possible source from which copper reached Mesopotamia in early times. It is scarcely necessary to say that the quantity of copper and bronze objects found is one of the not least remarkable features of recent excavations on early sites in Sumeria. It has almost revolutionised our conception of the early stages in the growth of civilisation.

The method followed by the Committee has been to analyse chemically as many samples of ancient copper and bronze objects as could be obtained for comparison with the analyses of ores from the various areas in which supplies of copper might have been accessible to the Sumerians. Examples of early date from areas other than Sumeria have also been analysed for purposes of comparison. In the present report, for example, Prof. Desch deals with objects from Susa, Ur, Kish, Bahrein Island, Egypt, including the sheet metal of the statue of Pepy I, now in the Cairo Museum, and North Arcot, India. Specimens from Mohenjo-Daro are still under examination, and samples from other localities still await attention. Egyptian fragments from various sites supplied by the Ashmolean Museum, Oxford, too small for analysis, were examined spectroscopically. Ores were obtained from Anatolia, Persia, Arabia, and Egypt. Prof. C. O. Bannister, as well as Prof. Desch, has taken part in the work of analysis.

An analysis of three specimens of bronze from the first grave at Ur, dated about 3500 B.C., showed that notwithstanding their early date, they consisted of a tin bronze, with nickel as a characteristic impurity. The figures were as follows:—

	A per cent.	B per cent.	C per cent.
Copper . . .	84·18	85·13	85·01
Tin	12·00	11·78	14·52
Lead . . .	1·62	1·13	0·47
Nickel . . .	2·20	0·25	trace
Iron . . .	—	1·71	—

Specimens obtained from the excavations at Kish in 1928 also contained nickel, though in smaller quantities, while of specimens obtained in 1925, copper from Mound A (3000 B.C.) showed nickel 3·34 per cent, and bronze from Mound W (Nebuchadnezzar) showed of nickel a trace, with 4·65 of tin and 6·16 of iron. Samples from Tel-el-Obeid showed respectively nickel 0·12 (from the frieze) and 0·23 (a nail); but a nail from Iraq of 2000 B.C. yielded no nickel.

In no case was there antimony.

Bronze dated with some probability at 1200 B.C. obtained by Sir Flinders Petrie from tumuli in Bahrein Island, yielded nickel in two cases in a percentage of 0·27 and 0·52. These specimens in the quantity of sulphur present showed evidence of imperfect smelting, while the proportion of tin present in some was so high as to render the bronze too brittle.

Among the Egyptian samples, the sheet metal from the statue of Pepy showed a remarkably high percentage of nickel—1·06. The Egyptian specimens examined spectroscopically showed no traces of gold or nickel. Some were pure copper; others showed traces of iron and arsenic, with, in one case, tin 5·25 per cent. The North Arcot specimens had 0·25 per cent of nickel.

Prof. Desch quotes analyses of three objects by Von Bibra from the North-West Palace of Nineveh found by Layard, containing 0·18, 0·30, and 0·20 per cent of nickel respectively, while J. Sibelien found 0·28 per cent of nickel in a Sumerian statuette (about 3000 B.C.) and 0·43 per cent in a copper adze of the First Egyptian Dynasty.

Having these results in view, and having regard to the fact that nickel is by no means an invariable constituent in copper ores, the aim of the Committee is now to find an ore which would be likely to yield nickel in such proportions. Native copper from Angora has yielded copper 99·83, a trace only of tin, 0·17 of iron, and no trace of nickel, while native copper from Arghana with 97·08 of copper, 0·27 of tin, 2·13 of iron, has 0·03 of nickel. A copper chisel of the early dynastic period yielded copper 93·21 per cent, silver 2·51 per cent, gold 4·14 per cent, lead 0·05, and arsenic 0·06 per cent, and was therefore probably composed of native metal.

Ores from Persia, the Black Sea, and the Sea of Marmora, Cyprus, various parts of Egypt and Sinai, yielded no result, all being free from nickel.

(*Continued on p.* 895.)

Supplement to NATURE

No. 3084 DECEMBER 8, 1928

The Quantum Theory.[1]

By Prof. H. S. ALLEN, University of St. Andrews.

IN a lecture on the quantum theory it might be thought fitting to commence with a clear explanation of the purpose, nature, and scope of the subject; but an attempt to answer briefly the question, 'What is the quantum theory?' would prove as baffling as Osborne Reynolds found the answer to the question, What is thermodynamics? He confessed that he felt tempted to reply:

"It is a very difficult subject, nearly, if not quite, unfit for a lecture. The reasoning involved is such as can only be expressed in mathematical language. But this alone should not preclude the discussion of the leading features in popular language. The physical theories of astronomy, light, and sound, involve even more complex reasoning, and yet these have been rendered popular, to the very great improvement of the theories."

The discussion of the quantum theory, however, presents a further and perhaps a greater difficulty. When Osborne Reynolds lectured on the general theory of thermodynamics in 1883, the foundations of the subject had been well and truly laid by the labours of those nineteenth-century leaders of physical science, Carnot, Joule, Clausius, Thomson, and Helmholtz. But even yet we are not quite satisfied as to the foundations of the quantum theory. Builder's rubble is still scattered over the ground, and the building itself is still in process of erection. Although the first stone was laid by Dr. Max Planck, professor of theoretical physics in the University of Berlin, on Dec. 14, 1900, the scaffolding has not yet been removed, and it is difficult, if not impossible, to get a bird's-eye view of the structure.

The quantum theory, though it has not attracted so much popular attention as the theory of relativity, has created problems of equal if not greater philosophical and scientific importance. The most acute question in physics at the present time is the problem of the nature of light. Is light corpuscular or undulatory in structure? In 1905, Einstein first suggested the hypothesis of light quanta. It is as though in digging the ground for the new theory he had unearthed the foundations of Newton's corpuscular theory and employed them in the construction of a new building; and all the time across the way was the magnificent structure of the undulatory theory of light erected by the labours of Huyghens, Young, and Fresnel, and enriched by the genius of Clerk Maxwell.

Up to the present no one has bridged the gulf between these two buildings. Many attempts have been made to build a bridge, but the keystone of the arch has not been fitted. Physicists are obliged to live sometimes in one building, sometimes in the other. We use either hypothesis according to the nature of the problem that we have under consideration, or, as Sir William Bragg expressed it in his presidential address to the British Association at Glasgow:

"On Mondays, Wednesdays, and Fridays we adopt the one hypothesis, on Tuesdays, Thursdays, and Saturdays the other. We know that we cannot be seeing clearly and fully in either case, but are perfectly content to work and wait for the complete understanding."

LIGHT QUANTA.

According to Einstein's hypothesis, the energy of radiation, instead of spreading out in all directions from the source as the undulatory theory of light would lead us to expect, is concentrated in certain bundles or units of energy so that propagation takes place in a manner closely resembling that met with in the corpuscular theory. There are certain phenomena which would lead us to the conclusion that the energy of a quantum is not only definite in amount, but is also concentrated in space, being always confined to a very small volume.

One way of picturing this concentration is to suppose with J. J. Thomson that the energy travels along discrete lines of electric force, so that the front of a wave of light would suggest the appearance

[1] From a lecture on "Some Philosophical Aspects of the Quantum Theory," delivered to the St. Andrews University Philosophical Society, Oct. 29, 1928.

of a number of bright spots on a dark ground. There are serious objections to this particular picture of the propagation of light, but it does seem necessary to suppose that each unit of energy can only be absorbed or emitted as a whole. This hypothesis is consistent with the experimental facts observed when electrons are separated from atoms by the action of light or X-rays—the so-called photoelectric effect. When the light quantum gives up its energy, it may be assumed that the energy is transferred to a single electron, so that the latter leaves the body with a corresponding amount of kinetic energy, allowance being made for the work the electron has to do in leaving the body. Einstein's hypothesis, however, seems inconsistent with the phenomena of interference and diffraction, which require some form of wave theory for their explanation.

The Radiation Problem.

Towards the close of the last century, an unexpected difficulty confronted physicists with regard to the spectrum of the radiation inside a hollow body maintained at a constant high temperature. The light issuing from a small opening in the wall of the enclosure was examined by using a prism, and the energy in different parts of the spectrum was measured. The results of such measurements could not be forced into agreement with classical theory. The latter predicts a definite relation between the energy emitted for a certain wave-length (or, more strictly, for a small range of wave-lengths) in the spectrum and the wave-length of that particular region. The results of the experiments do not conform with this relation.

If we adopt the principles of classical mechanics in dealing with radiation, as was done in an important investigation by the late Lord Rayleigh, there seems no escape from the conclusion that the way in which the energy is distributed amongst the wave-lengths in a normal spectrum must follow a definite mathematical law, now known as Rayleigh's law. According to this law, the energy should be the greater the smaller the wave-length of the radiation considered; in fact, for very short wave-lengths the energy should tend to assume an infinitely great value. This is directly contrary to experience. Careful experiments have shown that the energy of radiation is a maximum for a particular wave-length, and when the wave-length is less than the particular value, the energy is smaller than the maximum, becoming extremely small for the very short waves.

It was to meet this difficulty that Planck assumed the existence of vibrators of frequency ν, which could only possess energies of amount $h\nu$, $2h\nu$, $3h\nu$, . . . and no other. Thus he introduced the hypothesis of energy quanta. According to this hypothesis, radiant energy of any assigned frequency ν can be emitted and absorbed only as an integral multiple of *an element of energy*, $h\nu$, where h is a constant of Nature, now known as Planck's constant.

We may feel some hesitation in speaking of an 'atom' of energy, since the energy depends upon the frequency and the true constant is the factor h; but we may say that the radiation behaves as though it were done up in parcels or bundles, each parcel possessing an amount of energy, $nh\nu$ (n integral), proportional to the frequency of the radiation considered.

Another way of regarding the matter is to pay attention to the factor h itself. This is a quantity having the 'dimensions' of *action*, that is, energy multiplied by time. It is probably significant that, in the theory of relativity, action becomes more important than energy, and action rather than energy is conserved.

There is yet another way of interpreting Planck's constant, and that is to regard it as determining a natural unit of angular momentum (J. W. Nicholson), the physical 'dimensions' of angular momentum being the same as those of action. The angular momentum may be expressed in terms of a unit $h/2\pi$.

Integral Relations in Science.

It is almost impossible to exaggerate the importance which attaches to the occurrences of integers in physical science. Integral relations between the *masses* of gases entering into chemical combination with one another confirmed Dalton's theory of the atomic constitution of matter (1803), a theory first suggested to his mind by a study of the physical properties of gases. The chemical elements are composed of extremely minute particles (atoms) which are indestructible and indivisible *in chemical changes*. The law of Gay-Lussac (1805), that there is a simple relation between the *volumes* of the interacting gases, led Avogadro to his celebrated hypothesis, which is based on a clear distinction between the molecule and the atom. The molecules of elementary gases are not necessarily the atoms themselves, but may consist of clusters of atoms moving about as though they were single particles.

The imagination is almost overwhelmed when we attempt to visualise the enormous numbers of atoms or molecules which are present in even a small amount of material substance. But we recall the story in the Arabian Nights Entertainment—"And then another locust came and carried off another grain of corn"—and we may then appreciate better the almost illimitable number of natural objects and processes.

The atomicity of electricity foreshadowed in Faraday's work on electrolysis was brilliantly established by the measurements of J. J. Thomson, who determined the charge of the electron, the fundamental unit of negative electricity.

Integral relations obtained by Millikan in his experiments on the motion of small electrified particles have furnished indisputable evidence of the atomic nature of electricity. Speaking of the beauty and precision of these results, he says: "No more exact or more consistent multiple relationship is found in the data which chemists have amassed on the combining powers of the elements, and on which the atomic theory of matter rests, than is found in the foregoing numbers." An electric charge wherever it is found consists of an exact number of specks of electricity (electrons) all exactly alike. Thus is confirmed the view suggested by Faraday that "the atoms of bodies which are equivalent to each other in their ordinary chemical action have equal quantities of electricity naturally associated with them."

The atomic number of an element represents not only the number of extra-nuclear or planetary electrons, but also the resultant positive charge of the nucleus itself.

We recall the fact that in 1815 Prout emphasised the nearly integral values of the atomic weights of a number of elements, and suggested that all the elements were built up of one common material, hydrogen. The atom of any other element he supposed to be an extremely stable combination of hydrogen atoms. This suggestion led to a close examination of atomic weights, but after a series of accurate experiments, Stas still obtained fractional values for certain elements, and was led to characterise Prout's hypothesis as "an illusion, a mere speculation definitely contradicted by experience." Within recent years the position has been completely changed through the discovery of the existence of isotopes, that is, substances differing in atomic weight, but having identical chemical properties. This discovery makes it possible to explain fractional atomic weights as arising from the existence of two or more isotopes, and thus justifies a revival of Prout's hypothesis.

Direct evidence in favour of the idea that an atom of, say, nitrogen is composed of hydrogen atoms is afforded by the experiments of Rutherford on the disintegration of the nitrogen nucleus by bombardment with a swiftly moving alpha particle. Again, the marvellous experiments of Aston, using his mass-spectrograph, have shown that a whole number may be applied to the relative *masses* of the majority of the elements when oxygen (O = 16) is selected as a standard. The masses of the atoms of almost all the elements measured may then be expressed as whole numbers to an accuracy of about one part in a thousand. This clearly suggests a return to Prout's hypothesis that the atoms of the elements are different aggregations of atoms of hydrogen. The modern statement of the hypothesis would be: "the atoms of the elements are aggregations of electrons and protons"—the proton being the positively charged part remaining when an electron is detached from a neutral hydrogen atom.

The Rutherford-Bohr Atom.

The dynamic model of the atom suggested by Rutherford (1911) and developed by Bohr (1913) may be termed an astronomical atom, as the motion of the electrons round the massive nucleus may be compared to the motion of the planets round the sun. The similarity arises from the fact that the force of electrical attraction between electron and nucleus obeys the same law as the Newtonian law of gravitation and is inversely proportional to the square of the distance between the bodies concerned.

Newton was the first to prove that the law of force, now familiar as the *inverse square law*, gives an elliptic orbit as required by Kepler's first law.

Kepler's second law of the constancy in the rate of description of radial areas means that the moment of momentum, or the angular momentum, of the particle about the origin is constant throughout the motion.

Let us consider an atom in which electrons are revolving about a nucleus and are subject to the force of electric attraction towards the nucleus, and for the time being let us neglect the mutual influence of the electrons upon one another. Then each electron must have a constant moment of momentum characteristic of its particular orbit.

In Bohr's first statement of his theory he dealt

with the problem of a single electron revolving round a massive nucleus, as in the neutral hydrogen atom. He employed the quantum condition of Nicholson, and in this way fixed the angular momentum of the electron, putting it equal to a multiple of $h/2\pi$. The electron can then revolve only in certain selected or 'permitted' orbits which are allowed by the quantum relation.

The simplest illustration of the application of the quantum condition is afforded by the circular orbits of the hydrogen atom. The innermost orbit corresponds to the normal state of the atom. But it is possible, according to Bohr's original presentation of his theory, for the electron to move in other stable orbits, and it is found that the radii of successive orbits increase as the squares of whole numbers, that is to say, as 1, 4, 9, 16, 25 . . ., and so on. The energy associated with a particular orbit varies inversely as the diameter of the orbit, and consequently inversely as the square of the corresponding 'quantum number.' The series of states thus suggested may be regarded as a set of energy levels. Bohr supposes that it is possible for an electron to 'jump' in some way not described from one such level to another and in so doing to emit or absorb radiation. When the electron falls from an outer orbit to the innermost orbit, a line of the Lyman series is emitted. If, however, the final orbit is the second from the centre, a line of the Balmer series is emitted. The Paschen series is produced when the electron passes into the third orbit.

In the later developments of the theory by Wilson and Sommerfeld, elliptic orbits were considered and it was found possible to give an explanation of the fine structure of the lines of hydrogen and ionised helium. In the discussion of the 'stationary states' of the dynamical system, certain quantum restrictions have to be imposed so as to determine the 'permitted' orbits. These quantum conditions may be expressed by saying that the integrals of action during a complete period must be a multiple of the constant h.

The Quantum Postulates.

The older quantum theory was based by Bohr upon certain fundamental postulates which represent a definite departure from the results obtained by considering a system of particles satisfying the laws of classical dynamics. The first postulate affirms the existence of 'stationary' states in which, contrary to the principles of Maxwell's electromagnetic theory, no radiation is either emitted or absorbed. The second postulate is contained in Bohr's frequency relation:

$$\pm h\nu = E' - E'',$$

which affirms that in the transition between two stationary states one quantum of monochromatic radiation is either emitted or absorbed. Here again appears a striking departure from classical theory, and even a departure from accepted ideas as to causality. For it looks as if the kind of radiation emitted depends not only on the state of affairs before the emission takes place, but also on the state after the emission has occurred.

Bohr's suggestion of 1913 that an electron attached to an atom could emit light only by making a discontinuous jump from one possible orbit to another, quite distinct, orbit has provoked much speculation. To explain this puzzling behaviour it has been suggested that the electron may have some freedom of choice, so that it is impossible to predict to which possible orbit the transition will take place.

In my opinion such a revolutionary hypothesis is not demanded either by the facts or by the model. It is better to regard the atomic model as imperfect in its original form, and to suppose with E. T. Whittaker that sufficient attention has not been paid to the happening at the place to which the jump occurs. Whittaker pictures two coincident electrons, one positive and one negative, at this place; the opposite charges annul one another and are without effect in the initial state of the system. Emission of radiation is brought about by some external agency which stimulates the discharge of a condenser composed of the excited outer electron and one of these two charges. The other charge is left surviving alone at the end of the process, which is accordingly equivalent to Bohr's notion of a translation of the outer electron to an inner orbit.

In a very interesting essay on the future of physics, L. L. Whyte has laid stress on the assumption of *reversibility* implicit in Newton's laws, which, he claims, is valid neither for atom nor for organism. If it were once admitted that any elementary process were irreversible, it would be necessary to give up the whole system of Newtonian conceptions, which are unsuitable for the treatment of irreversible effects. In his suggestive volume "Archimedes" the issue is formulated thus:

"Is there a real temporal process in Nature? Is the passage of irreversible time a necessary element in any view of the structure of Nature? Or, alternatively, is the subjective experience of time a mere illusion in the mind which cannot be

given objective expression ? These are not metaphysical questions that can still be neglected by science with impunity. . . . Moreover, the above questions may be put into precise scientific form by asking if the causal relations which are studied by science are symmetrical and reversible so that we cannot obtain from them any criterion by which to distinguish past and future. If, on the other hand, they are asymmetrical and irreversible, the laws of Nature lead us on necessarily from what went before to what comes afterwards."

If Born is correct in asserting that all quantum processes are irreversible, the philosophical implications are of the utmost importance.

In classical dynamics a knowledge of the position and velocity of all the particles composing a system determines the future motion of the system, and that completely. Thus, when the state of the system is known at a particular instant, it is possible (theoretically) to foretell the state of that system at any later instant.

Laplace visualised this possibility in a famous passage :

" A mind to which were given for a single instant all the forces of Nature, and the mutual positions of all its masses, if it were otherwise powerful enough to subject these problems to analysis, could grasp, with a single formula, the motions of the largest masses as well as of the smallest atoms ; nothing would be uncertain for it ; the future and the past would lie revealed before its eyes " (" Essai philosophique sur les probabilités," 1840).

This expresses the meaning of the principle of causality on the basis of the older dynamical theory. The idea of knowing exactly the state of a system at some given moment is never realised in practice, and consequently the introduction of considerations of probability is justified and statistical methods were frequently employed.[2]

Matrix Mechanics.

Heisenberg put forward the demand that only such quantities as are observable should be represented in the mathematical formulation of atomic theory. The selected orbits of the older theory cannot be directly observed and cannot, even ideally, be subjected to measurement. On the other hand, the frequencies and intensities of the light emitted, scattered, or absorbed by an atom can be both observed and measured. This led to the development of the matrix mechanics, every term in a matrix corresponding to something which is, at least ideally, observable. The dynamics of matrices may be regarded as a generalisation of classical dynamics, the latter being the limit of the former. Instead of the quantum conditions of the earlier theory, the quantum constant h is now introduced in an equation expressing the fact that the rule of multiplication in the new mechanics is non-commutative. In fact, if p and q are conjugate canonical variables, we have $pq - qp = h/(2\pi i)$. This is known as Heisenberg's uncertainty relation.[3]

There is a further point of difference between classical mechanics and the more recent quantum theory, which has been emphasised by Heisenberg. In the older theory the position of a particle can be definitely fixed at a specified moment by means of its co-ordinates. As the time varies it is supposed to be possible to follow the track of the particle through space, or to determine its ' world-line ' in the four-dimensional world. In the new quantum theory both the position and the path of a particle become vague. It is argued that the position or trajectory of an electron can only be determined by illuminating the electron by a beam of light, and this illumination itself will interact with the electron, rendering the exact measurement of position or path impossible. There is an element of uncertainty in the proposed determination, the amount being specified by Heisenberg's ' uncertainty relation.'

This relation involves the positional co-ordinate q, and also the momentum (impulse co-ordinate) p, and may be interpreted by saying that when we try to determine exactly where the electron is—and to do this we have to use a beam of light—it behaves in such a way that we are unable to measure simultaneously its exact velocity.

Wave Mechanics.

Louis de Broglie threw fresh light on the difficulties which had become so serious in quantum theory, in a series of papers in which a material particle was regarded as closely associated with a group of waves having velocity and wave-length governed by the speed and mass of the particle. Every such particle when at rest is the centre of a pulsation extending throughout space. This means that the ' particle ' is to be treated as a singularity of a pulsation which at any given time is in the same phase through space. We may consider these pulsations throughout boundless space as in some respects analogous to standing waves along

[2] See an article by H. F. Biggs (Nature, Vol. 121, p. 503; 1928).

[3] The occurrence of the imaginary quantity $i = \sqrt{-1}$ in this equation is remarkable, and may be significant. Written in the form $ipq - iqp = h/2\pi$, the relation suggests that the fundamental phenomenon in microscopic processes is gyroscopic in nature.

a finite string or in an organ pipe. Another imperfect analogy may be found in the vibrations of a bell or Chladni's plate.

When the 'particle' is moving with reference to the observer with uniform velocity, the pulsations will no longer be simultaneous but will be represented by travelling waves.

"The 'region occupied by the particle' is the region where a set of these waves, varying continuously in direction and in frequency over a small range, reinforce each other to form a *wave-group* travelling with what we call 'the velocity of the particle.'"

The velocity of a particle thus appears as a *group velocity*. The consequences of this theory, as developed by Schrödinger and others, have been tested by their application to problems of spectroscopy and by more direct evidence derived from experiments on the reflection of electrons from crystals (Davisson) and on the patterns formed by the passage of cathode rays through very thin films (G. P. Thomson). These patterns are similar to those obtained with X-rays in the 'powder' method and agree in dimensions with the predictions of wave mechanics.

An interesting, though somewhat problematical, application of the ideas of de Broglie accounts for the integral relations in Bohr's circular orbits. By imagining a ray of the waves to travel round the circular orbit, and introducing the condition that the circumference contains a whole number of wave-lengths, the angular momentum of the electron is restricted to the values previously assigned. In this connexion it is interesting to recall the views of Sutherland (1901) with regard to the origin of lines in spectral series. He came to the conclusion that the series must arise from kinematical considerations, and explained them by considering the nodal subdivisions of a circle. A similar idea was put forward in the Physical Society discussion on the ring electron in 1918.

Views analogous to those of de Broglie have been published by J. J. Thomson in a lecture entitled "Beyond the Electron" (1928). The electron "has a dual structure, one part of this structure, that where the energy is located, being built up of a number of lines of electric force, while the other part is a train of waves in resonance with the electron and which determine the path along which it travels." This view is very similar to the view of the structure of light suggested by J. J. Thomson in 1924. "This duality is a necessary consequence of the transmission of energy through the ether by waves: for this involves two things, the transmission of energy and the propagation of the waves." The transmission of energy takes place with the 'group' velocity, the transmission of waves with the 'wave' velocity. "If we concentrate on the waves we have an undulatory theory; if on the energy a corpuscular one."

The most promising attempt yet made to *explain* quantum phenomena and the existence of quantum numbers is undoubtedly that of Schrödinger in his undulatory mechanics. We have here the nearest approach to classical principles in the formulation of the wave equation and in the suggested interpretation of the wave function ψ.

As pointed out long ago by Hamilton, there is a close analogy between mechanics and optics; in fact, his theory of mechanics grew out of his "Optics of Non-homogeneous Media." Classical mechanics is analogous to geometrical optics. The motion of a material system may be studied by considering the path of a mass-point in configuration space, that is, the space of the variables which are *positional* co-ordinates. To the path of this representative point in configuration space there corresponds the path of a ray of light in geometrical optics. But we know that geometrical optics fails to account for the facts and must be replaced by undulatory optics as soon as the obstacles or apertures are no longer great compared with the wave-length. We also know that in the atomic domain classical mechanics fails, the failure becoming evident when the curvature of the path becomes very great. This suggests that we really require an undulatory mechanics which may be regarded as the Hamiltonian analogy of undulatory optics. Wave mechanics bears to ordinary mechanics the same relation as undulatory optics bears to geometrical optics.

It has been said in picturesque language that according to Schrödinger: "Nature is not made up of electrons but of waves. The atom must be considered as a system of electric waves spread over its whole volume. 'Electrons' are merely an inaccurate way of describing some of the properties of these waves" (L. L. Whyte).

It is important to remember, however, that Schrödinger's waves are not waves in ordinary space, but waves in 'configuration space,' which has as many dimensions as there are degrees of freedom of the system. Disregarding rotation, this would be $3N$ for a system composed of N particles. It is only in dealing with the one-electron problem that we are able to use space of three dimensions.

In macro-mechanical problems classical dynamics

may be employed. In micro-mechanical motions the equations of the old dynamics are no longer valid; they must be replaced by a *wave-equation* in configuration space. This equation contains a parameter E, which corresponds to the mechanical energy in macroscopic problems. It is only for certain special values of E, the *proper values*, that the wave equation possesses solutions which (together with their derivatives) are one-valued, finite and continuous throughout configuration space. These proper values include the 'energy levels' of the older quantum theory, the quantum numbers arising in a straightforward way out of the wave-equation. Thus in Schrödinger's undulatory mechanics "quantum numbers are accounted for in a perfectly natural way, practically on classical principles," or, as de Broglie has expressed it: "The appearance of integers in the dynamical formulæ ceases to be mysterious, and becomes as natural as their occurrence in the theory of vibrating strings or of wireless antennæ."

The integral relations thus obtained represent one of the triumphs of the new theory, and it is found that when the energy levels thus determined are not in exact agreement with those previously deduced, the deviations are all actually in favour of the new mechanics. It is especially noteworthy that the results of Heisenberg's quantum mechanics agree with those of the undulatory mechanics, where there is a difference from the old quantum theory. As Schrödinger points out, this is the more remarkable, as the whole mathematical apparatus seems fundamentally different in the two methods.

Dirac has developed an even more general method of treatment, which may be called a quantum algebra. For the representation of atomic quantities he introduces quantum variables or quantum numbers (q-numbers). These are subject to the ordinary arithmetical laws, with the exception that they do not obey the commutative law of multiplication. By employing certain additional hypotheses, Dirac is able to express the mechanical laws in Hamiltonian form. Born and Wiener have suggested that quantum magnitudes may be considered as functional operators, an idea that would account for the failure of the commutative law, since the successive application of two *operations* may depend on the order in which they are carried out. A further point of interest to the mathematician is the analogy between the theory of matrices and that of integral equations (Lanczos).

The New Outlook.

We may summarise the chief results of this recent work as follows. In classical theory we have been accustomed to deal with point events and with the movement of mass particles. Now the picture becomes blurred, or at least less sharp and clear. No longer are we to consider a mathematical point in three-dimensional space, but instead a small *region* in the space-time world. The concept of a massive particle of infinitesimal size is to be replaced by the idea of a focus of waves. For the path of a particle, which corresponds to a ray in geometrical optics, must be substituted the track of a group of waves as in physical optics. In spite of these differences in outlook, we are assured by Bohr that we have to deal not with *contradictory* but with *complementary* pictures.

The older or classical quantum theory is based on stationary states and quantum jumps. Schrödinger endeavoured to retain so far as possible classical conceptions, in which there are no discontinuities. Thus there has arisen a difference in outlook between Schrödinger and other workers in this field. For example, Born and Jordan hold that Schrödinger's relations have to be interpreted in a statistical sense. According to Schrödinger, quantum mechanical laws can be expressed by quite ordinary differential equations; according to Born, the reason why it is possible "to represent anything in the discontinuous confusion of quantised atomic processes by differential equations, is that the function which is to satisfy the differential equation is a probability."

Jordan (Nature, vol. 119, p. 568; 1927) sums up this position in the following words: "Classical physics described the world in terms of quantities continuously propagated in space and time. The quantum theory describes the world in terms of an abstract, many-dimensional configuration space, and the number of dimensions is proportional to the total number of particles in the world. In this abstract space we have again the propagation of continuous quantities; but these no longer tell us directly about the single atomic phenomena, but rather about the probabilities of the quantum processes. Determinism—not as a metaphysical distinction from chance, but in the physical sense explained above—has the same formal validity in both theories."

Jordan concludes his review of the philosophical problem by saying: "Probably we shall find that an incomplete determinism, a certain element of pure chance, is intrinsic in these elementary physical laws."

Earlier in this address, emphasis was laid on the requirement that light should possess a certain structure so as to afford points of concentration of radiant energy—a requirement which is difficult to reconcile with the undulatory theory. On the other hand, it now appears necessary to introduce into the classical picture of material particles some of the characteristics of wave motion. Is it possible to combine these two problems into one and effect a synthesis between a corpuscular and a wave theory both for radiation and for matter? This question has been discussed by de Broglie, who suggests that the exact description of the phenomena can only be given through the consideration of waves *which admit of singularities*. In his view the material particle is an essential reality, and its motion is completely determined as that of a singularity in the amplitude of a wave which is propagated.

"It would in this way be possible to retain the atomic structure of matter and of radiation, as

well as the determinism of individual phenomena, while at the same time attributing to the continuous solutions the statistical meaning which Born and implicitly Schrödinger have recognised in them."

Bohr has discussed the significance of recent developments in the quantum theory in an important, though difficult, paper published last April (NATURE, Vol. 121, p. 580). The quantum postulate "attributes to any atomic process an essential discontinuity, or rather individuality, completely foreign to the classical theories, and symbolised by Planck's quantum of action." Bohr believes that the causal space-time description of phenomena to which we are accustomed in dealing with macroscopic phenomena may fail us when we have to do with atomic (microscopic) phenomena. This failure arises from the small value of the quantum of action as compared with the actions involved in ordinary sense perceptions. The situation is illustrated by considering the question of the measurement of the co-ordinates of a particle, taking into account Heisenberg's relation between them. This relation implies a certain maximum precision with which the space-time co-ordinates and momentum-energy components of a particle can be measured simultaneously.

At the outset we compared the corpuscular theory and the wave theory to two separate buildings. Perhaps Bohr's latest work may be regarded as an attempt to dig an underground passage between the two, but the tunnel is dark and gloomy, and the atmosphere scarcely fit for human respiration. We might wish to find another solution like that proposed by the philosopher Alice in "Through the Looking-Glass":

"She went on and on, a long way, but wherever the road divided there were sure to be two finger-posts pointing the same way, one marked 'TO TWEEDLEDUM'S HOUSE,' and the other, 'TO THE HOUSE OF TWEEDLEDEE.' 'I do believe,' said Alice at last, 'that they live in the same house! I wonder I never thought of that before.'"

But Alice never found the house, and when she met the two little men, conversation proved difficult.

"I know what you're thinking about," said Tweedledum; "but it isn't so, nohow."

"Contrariwise," continued Tweedledee, "if it was so, it might be; and if it were so, it would be; but as it isn't, it ain't. That's logic."

We had better abandon the simile of the house and try another analogy. We may liken the 'complementary' theory of Bohr to a see-saw on which Tom Particle and Mary Wave are so evenly balanced that a touch will send one end of the plank up or down. If we attempt to fix one end to mother earth, the other is suspended in mid-air. But fixity is not one of the essentials of a see-saw, and however much we may desire a firm foundation for a scientific theory, it is at least possible that fixity is not attainable by finite human intelligence. Bohr concludes his article by pointing out that in the scientific situation there is a deep-going analogy to the general difficulty in the formation of human ideas, inherent in the distinction between subject and object.

In philosophy, as in science, it is generally admitted that there has been a movement away from the mechanical view of Nature which dominated the nineteenth century. The new movement, as expressed, for example, in the writings of A. N. Whitehead, is towards "the recognition of purposiveness and creativeness in Nature." It is difficult to understand all the implications of Whitehead's work, but in his view, as in that of Bergson, the basic idea of *process* must be employed in building up a scientific philosophy. In the organic theory of Nature we have to consider, not a bit of material as in the materialistic theory, but a complete *organism*. In the physical field the primary organisms appear to be vibratory entities, and a proton or electron may perhaps be regarded as a vibrating pattern—a view not very different from that of Schrödinger. "The path in space of such a vibratory entity—where the entity is constituted by the vibrations—must be represented by a series of detached positions in space." Thus it will be seen that Whitehead's views are in harmony with the ideas of the quantum theory, although it is as yet too early to regard that theory as entirely comprehensible.

What, then, is the conclusion of the whole matter? Biologists, chemists, engineers, and also philosophers, are looking to the physicist to give a clear pronouncement as to the nature of fundamental physical processes. At the present moment no clear unambiguous reply is possible. We are still at the stage in which exploration of scientific facts is needed, and, on the other hand, candid examination of the basic ideas in philosophy is required. One lesson at least is emphasised by the recent history of scientific thought, and that is the necessity for caution and modesty in our approach to these fundamental conceptions. We often find discarded theories re-born, and we may learn even from the mistakes of the leaders in science.

Truth, in the realm of physical science, is no longer enshrined in a pellucid crystal sphere. Rather it is to be found in a quivering, pulsating orb of fire. The rainbow colours change as we gaze upon it, and from time to time dark clouds obscure our view. In the search for truth the mental philosopher and the natural philosopher must join forces; and the quest is worth while: "For wisdom is more mobile than any motion. Yea, she pervadeth and penetrateth all things by reason of her pureness. For she is an effulgence from everlasting light."

Printed in Great Britain by R. & R. CLARK, LIMITED, *Edinburgh.*

Recently, however, an ore was found, accompanied by slag, at Jabal al Ma'adan in Wadi Ahin, inland from Sohar, in the State of Oman, which proved to contain nickel. It was found only in the form of thin veins, much mixed with other minerals. The percentage of copper was small, but that of nickel relatively to the copper was very high. The figures were copper 1·0, nickel 0·19. The slags contained 1·50 and 4·30 per cent of copper and no nickel, which is in accordance with probable smelting practice.

The Committee has thus achieved a tangible and encouraging result, though it would be going beyond the evidence at the moment to suggest that it is conclusive. Mr. H. Peake, however, in a communication presented to the recent Orientalist Congress at Oxford, suggested that Jabal al Ma'adan might be the site of Magan, referred to by Sargon in his geographical tablet and mentioned in the time of Judea in the lists as one of the places from which came ships and copper.

On the other hand, Prof. Desch mentions an ancient bronze object from the Transvaal which contains so much as 3 per cent of nickel. He thinks that as the copper ore, which is malachite in a quartz gangue, is accompanied by a green nickel arsenate, anabergite, this might have been mistaken for malachite, thus explaining the presence of nickel. This is suggestive, for it is known that farther to the north in the Belgian area nickel blooms have been used. Although vast quantities of metal have been taken from the Transvaal and Katanga area, the age of these workings is quite unknown. It certainly should be investigated. Another research committee of the British Association has this question under consideration, but is unable to continue its investigations owing to lack of adequate funds.

Obituary.

PROF. R. A. BERRY.

THE sudden death of Reginald Arthur Berry, which took place in Glasgow on Oct. 12, at the early age of fifty-two years, deprives Scotland of one of its most active workers in agricultural science. Berry was educated at Oundle and at Cambridge. After acting as assistant for several years to the late Prof. Liveing, he transferred in 1900 to the School of Agriculture at Cambridge. There he worked with Prof. T. B. Wood for the next five years, and, in collaboration with him, published some valuable papers; in particular their investigation into the composition of root crops has always been regarded as a fundamental piece of work.

In 1905, Berry was appointed professor of agricultural chemistry in the West of Scotland College of Agriculture at Glasgow. Here his teaching duties were heavy, and his laboratory accommodation meagre and inconvenient; notwithstanding these difficulties he steadily carried on his work, and the large number of papers published during the last twenty-three years bears evidence to his zeal and to his wide interest in the various divisions of agricultural chemistry. An investigation into the composition of oats was followed by a large number of papers dealing with feeding problems and with various aspects of dairying; he did much work on the utilisation of the by-products of the dairy industry, and, at the last meeting of the British Association in Glasgow, presented, in conjunction with Mr. A. Macneilage, the results of an inquiry of much economic importance into the utilisation of surplus milk. Berry was also much interested and took a share in the development of the modern methods of soil surveying which have been adopted in Great Britain; he was an active member of the Scientific Advisory Committee to the Royal and Ancient Golf Club.

Berry married the elder daughter of the late Mr. James Smith, of Doonfoot, Ayrshire, and is survived by his widow and two daughters. He had a wide circle of friends, by whom his memory will ever be held in affectionate remembrance.

MR. S. R. PIKE.

THE death occurred on Nov. 22, in hospital at Pasadena, California, of Sydney Royston Pike. Mr. Pike was born in 1903, and showed a marked bent towards astronomy from early years. He entered Balliol from Bedford School in 1920 with a scholarship awarded for distinction in that subject. Graduating with a first class in physics in 1924, and following this up by a year's research in Oxford, he was appointed assistant lecturer in physics in the University of Leeds in 1925, and soon showed his originality by a series of papers on astrophysical subjects. During the present year, having been awarded a research fellowship by the International Education Board, and granted a year's leave of absence by the University, he proceeded to Mt. Wilson in September, and had scarcely begun work when symptoms of meningitis, following a severe chill, necessitated his removal to hospital.

In letters Mr. Pike had remarked on the universal kindness with which he had been received by his new friends in California. To all of them his relatives and English colleagues wish to express their deepest gratitude. They also wish to record their high appreciation of the generous action of the American authorities under whose auspices Mr. Pike was working, in according him a last resting-place near the great observatory in which his labours were so prematurely cut short.

WE regret to announce the following deaths:

Prof. T. C. Chamberlin, emeritus professor of geology in the University of Chicago, the Nestor of American geologists, who was a foreign member of the Geological Society of London, on Nov. 15, aged eighty-five years.

Dr. V. E. Emmel, professor of anatomy in the college of medicine of the University of Illinois, on Nov. 8, aged fifty years.

Prof. Franz Stuhlmann, formerly general secretary of the Hamburg Colonial Institute and one of the pioneers in the opening-up of German East Africa, who accompanied Emin Pasha in his last expedition in 1894, aged sixty-five years.

News and Views.

PRESENT-DAY physics is in a state of flux. Rival theories have been advanced with startling rapidity to explain the ultimate structure of the atom—in so far as such an explanation may ever be possible. In their present state, such theories are of a professedly mathematical complexion and unfitted for universal consumption; some old conceptions are being discarded and others are being resuscitated. In a supplement to our issue this week, Prof. H. S. Allen gives a sketch of the rise of the quantum theory and in general terms its present position. To many who desire a clear statement of the case, such a summary will be interesting, but in a measure disappointing. As Prof. Allen points out, the position is as yet by no means cleared up. Are we to regard light as corpuscular or undulatory, or both? Has the electron an objective existence? Are the ultimate processes of Nature reversible or not? These are some of the questions to which an answer is eagerly awaited. We are in the position of a man standing before a locked safe which contains the answers to all the riddles of the universe. Around him are uncountable stacks of keys. By patient trial he has found some which nearly fit the lock. Perhaps the right key is among those which he has chosen and the non-success of his efforts to open the safe is due to faulty manipulation of the key. Perhaps, after all, the right key has yet to be tried.

THE situation in physics is certainly promising. It must be borne in mind that the application of mathematics to actual phenomena is of a two-fold nature. A suitable mathematical clothing has to be found. The rules of mathematical reasoning are applied to the symbols used, and equations are deduced or numbers calculated. This is the province of mathematics proper. The crux arises when these results are to be interpreted in connexion with the events to which they are to be related. The physicist points a finger and demands 'What does this mean?' And the answer given is not always to his liking. Possibly the interpretation is unsuitable, possibly it appears to contradict notions long established, or possibly the clothing is a misfit. The quantum theory has appeared in strange garbs, but the fact that they are mathematically reconcilable seems to rule out the last possibility and leaves us hopefully expectant of what the future may bring forth.

ONE of the professed objects of the British Science Guild, founded twenty-three years ago by the late Sir Norman Lockyer, is to educate public opinion by spreading the knowledge of scientific achievements and the results of scientific contemplation. With the view of furthering this particular aim, there was recently instituted the Norman Lockyer Lecture, and the fourth of this annual series was delivered in London on Nov. 28 by Prof. J. Arthur Thomson, of the University of Aberdeen. The subject of the address, "The Cultural Value of Natural History," touches a theme upon which natural historians have been too reticent, for the tendency in recent years has been to lay stress upon the economic and practical aspects, and to allow to drift into the background the mental and spiritual aspects, which perhaps appeal more strongly to the man of general education. It is clear, from Prof. Thomson's analysis, that the knowledge and study of living things, not necessarily in a profound, but in a contemplative fashion, possesses a cultural value which cannot be altogether matched by any other branch of knowledge.

IN neat phrases and with a wealth of example, taken largely from recent investigations, the seven contributions of natural history to human culture were driven home by Prof. Arthur Thomson. Power is added to our vision of the world—"the eye sees what it brings with it the power of seeing; and well-informed vision is richest and clearest." The æsthetic sense is cultivated—"there is no risk of the cold light of science hurting the æsthetic emotion, for the more we know of a beautiful thing the greater is our enjoyment." Interest is stimulated—"natural history gives us glimpses of a dramatic world." Big ideas, such as evolution and the interrelations of living things, of world-wide significance, are its progeny. Its problems present infinite variety of mental discipline and resolute thinking; and the deep impressions made by even superficial contact with Nature are of fundamental value in moulding outlook. Finally, there is guidance in human affairs to be found in a rational study of animate Nature—"a society that dispenses with sifting is working its own doom"; "success attends the small families among animals well-equipped in body and mind"; "in bygone days we heard much about original sin, we need to hear more about original righteousness," and so on. This interesting address has been printed by the British Science Guild and may be obtained from the offices, 6 John Street, Adelphi, W.C.2 (Price 1*s*.). The Guild requires financial support to enable it to carry on and extend its useful work for the public good, and we heartily endorse its appeal for new members.

IN a progress report submitted by the Distemper Research Committee to the *Field* Distemper Council and the Medical Research Council, Dr. P. P. Laidlaw and Mr. G. W. Dunkin describe the present position of the research work carried out since 1923 on canine distemper and the various steps by which the results obtained have been achieved; an account of this work was given in the *Times* of Nov. 29. The investigation has reached the stage at which vaccination against distemper becomes a practical proposition on a large scale, although improvement in methods is certain to occur in the future. The method at present in use, which has been found very successful in the field, consists of a double inoculation. The first is made with a vaccine which is, in fact, the inactivated virus of the disease; the second, ten days later, with an attenuated strain of the living virus; the dose of the latter is about a hundredfold that necessary to infect a dog not previously treated with the vaccine, but it produces no upset, or only a slight disturbance, in the general health. Complete resistance to the disease is thus produced, both to injection of infective material and to exposure to contact with an infected animal.

THAT this work on dog distemper has not yet reached finality is shown by the fact that among other lines of investigation being pursued, two lead to the hope of improvement in the method of protection, and also of throwing light on the nature of virus disease in general as it affects both man and animals. There is a possibility that a potent antiserum may be available in the future: this would act as a curative agent for dogs already suffering from distemper, and also, by combination with living virus, as an agent for producing complete protection with only one inoculation; the serum would prevent the animal from having more than a mild attack of fever, whilst the virus would confer a lasting immunity. Finally, the problem of cultivating the virus outside the body is still being actively pursued. Absence of a suitable method makes the preparation of the vaccine a laborious task: the discovery of such a method would undoubtedly advance enormously our knowledge of the other virus diseases and bring nearer the time when satisfactory methods of prevention and cure would be generally available. We understand that the Wellcome Foundation is undertaking the conversion of the laboratory processes into large-scale production of vaccines suitable for the general inoculation of dogs against distemper.

IT is announced in the *Times* of Nov. 30 that Sir Otto Beit has offered £50,000 to King Edward's Hospital Fund for London for the purchase of radium for use in the hospitals. In a letter to the honorary secretaries of the Fund, Sir Otto Beit refers to the fact that the hospitals of London, speaking generally, are not adequately provided with this method of treatment and that he seeks to remedy this state of affairs. The Distribution Committee of the Fund, assisted if necessary by members of the medical profession co-opted *ad hoc*, will decide upon the proportion and the manner in which the gift shall be applied, but the donor especially desires the Committee to secure that the hospitals thus to be provided on loan with radium should be preferably those in which the cure of disease or the alleviation of suffering is associated with a keen interest in the furtherance of the knowledge "for the relief of man's estate." This gift is one more example of Sir Otto Beit's extraordinary generosity in assisting medical work. Readers of NATURE will not need to be reminded of the institution of the Beit Memorial Fellowships for medical research in 1910, or of the way in which they have been supplemented since. It will be noticed that, in the letter of Sir Otto Beit making the offer of this gift, which, it is needless to say, has been gratefully accepted, no mention is made of the diseases which are to be treated with the new supply of radium. There can be little doubt, however, that a big fraction of it will be used in the treatment of cancer. This whole question has now become a national one, and this great gift, which is an expression of public confidence in the utility of radium as a therapeutic agent, will help any national scheme which is launched under the right auspices.

THE first reports on the Chilean earthquake of Dec. 1 show that it must have been one of great violence, and it is to be feared that the losses of life and property have been under-estimated. The shock, which occurred between 5 and 7 minutes after midnight, seems to have caused most damage at Talca, a town about 50 miles from the coast. Here, it is said, 85 per cent. of the houses are destroyed, including most of the important buildings. The area of damage is of great size. It extends from Teniente on the north to Chillan on the south, a distance of 200 miles, and it includes Constitucion on the coast due west of Talca. As there is no mention of any sea-waves, it is probable that the epicentre in this case lies on land. From Valdivia and Concepcion northwards, the whole of Chile is subject to violent earthquakes. In the neighbourhood of Talca there are several earthquake-centres, but none of the importance of those that lie near Concepcion to the south, and Valparaiso to the north, of Talca. During the present century there have been two great earthquakes in Chile, the Valparaiso earthquake of Aug. 17, 1906, with its submarine origin between Valparaiso and Coquimbo, and the Coquimbo earthquake of Nov. 10, 1922, with its origin also submarine, and extending northwards from Coquimbo for one or two hundred miles towards Chanaral. The recent earthquake thus points to a migration of the seat of activity several hundred miles to the south.

"MAN'S Mental Aptitudes" is the title of an amusing and significant article by Sir Arthur Keith in the *Rationalist Annual* for 1929. On the assumption that the editors of newspapers publish what people wish to read, he has analysed the space allotted to various interests in the columns of a few papers representative of different classes of readers. In the 'superior' London and northern England papers the results are wonderfully consistent. They indicate that business interests come first in the Englishman's mind, with just one-third of the total space of the 'superior' London daily. Then follow, in descending importance, politics, which Sir Arthur takes as showing the scale of patriotism, intellectuality, sport, artistic and scientific interests, sensational news, and, last, religion. The popular London daily gives the same order, except that sport precedes intellectuality and sensational news precedes art and science. The "most widely read Sunday newspaper," taken to represent the mental fare of 'cottagers,' stands in quite a different category. Here interests are topsy-turvy; sensational news leads with a quarter of the total space, and is followed by sport, intellectuality, business, politics, art, and science. The low percentage of scientific news, from 4 to less than 0·5 per cent, is remarkable, but this and other anomalies may be due to the limitation of the investigation to a few issues, so that a fair average was not available. Some newspapers reserve their special scientific articles for a definite day of the week. Sir Arthur's summing up is a very reasonable conclusion from this original study. "A survey of man's nature, as reflected in the columns of the newspapers he buys and consumes, shows that it is not the intellectual side of his brain which dominates his nature, but the emotional and passionate. Man is essentially an animal of the 'heart' rather than of the 'head,'

and in all our speculations as to his future, this aspect of him must be ever borne in mind."

A WIRELESS beacon installation built at Start Point by Marconi's Wireless Telegraph Co., Ltd., for the Corporation of Trinity House has just been completed. This installation is the seventh of its kind now established round the British coasts. The completion of the Start Point transmitter means that very effective cross bearings can now be taken by ships, for there are now three Channel stations which can be used as fixed points, and they can thus obtain a sequence of bearings and be sure of their position right up the Channel. The transmitter of the type fitted in the British Isles has a power of 500 watts and is operated on a wavelength of 1000 metres, which is the specified wavelength for wireless beacon stations, and the whole equipment is automatically controlled by a master clock for transmitting groups of interrupted continuous wave (I.C.W.) signals at pre-arranged intervals. The call sign of the Start Point station is GSM and accurate direction-finding bearings may be expected up to about 100 nautical miles under normal atmospheric conditions. One of the advantages of the system of position finding in which a wireless beacon station of the Marconi type at a known position is used in conjunction with a direction finder on board ship is that the signals are broadcast in all directions and a direct bearing can therefore be taken on the transmitter from any direction at every signal sent out by it.

IT has been decided that the eighty-eighth annual general meeting and the anniversary dinner of the Chemical Society shall be held in Leeds on Thursday, Mar. 21, 1929. It is the desire of the Council to make this a special occasion for a general gathering of chemists and those associated with chemistry in the north of England, and in order that these meetings may be representative of all branches of chemistry and chemical industry, the local sections of the Society of Public Analysts, the Institute of Chemistry, the Society of Chemical Industry, the Society of Dyers and Colourists, and the Coke Oven Managers' Association are co-operating. The annual general meeting will be held in the University of Leeds on Thursday, Mar. 21, at 4 P.M., and the anniversary dinner will take place in the Town Hall, Leeds, the same evening. The Railway Clearing House has granted facilities by which those attending the meetings will be able to travel from all parts of Great Britain to Leeds at the reduced rate of an ordinary fare and one-third for the double journey.

THE British Boot, Shoe, and Allied Trades Research Association held its first annual president's reception and dinner on Wednesday, Nov. 28, at the Hall of the Worshipful Company of Cutlers, Warwick Lane, E.C.4. Sir William Bragg was the principal guest, while Prof. H. C. H. Carpenter and Mr. A. L. Hetherington attended, representing the Department of Scientific and Industrial Research. In proposing the toast of the Association, Sir William gave an inspiring address, and Prof. Carpenter, as chairman of the Industrial Grant Committee of the D.S.I.R., responding to the toast of the Department, announced the new conditions under which the Department would continue grant aid to the Association. This Research Association was one of the first to be formed, so that much credit is due to the small nucleus of far-seeing boot manufacturers who constituted its initial small membership. Unfortunately, the enthusiasm of the few did not rapidly spread, and although in recent years the membership and influence of the Association have steadily grown, it still remains the smallest industrial research association in Great Britain. This dinner is the first the Association has held, and it is gratifying to find that there are many signs that the footwear industry as a whole is now rapidly awakening to a realisation of the immense possibilities that lie in close co-operation between specialised scientific research and industrial processes.

AT the meeting of the Institute of Fuel on Nov. 21, Lord Melchett delivered a presidential address mainly on the economic condition of the British coal industry. The reorganisation of industry now in progress was likened to the industrial revolution following the introduction of coal and iron. Modern technical advances tend to reduce coal consumption for all purposes, and this, combined with the over-development of world production, has brought about the severe depression and unemployment in Great Britain. In the first place, commercial organisation is essential to avoid the ruinous competition, which ends in the folly of selling at unremunerative prices. The re-establishment of the coal trade necessitates reorganisation of its technology, commercial and labour relations, followed by international agreements with other exporting countries. Internal reorganisation should proceed without delay. That coal is a chemical raw material is now receiving fuller recognition, and a problem which follows naturally is the conversion of coal into oil. This problem will undoubtedly yield an economic solution in the next decade. The direct employment of coal for what it is, namely, a complicated chemical substance, is yet in its infancy. Any revival in the coal trade must have direct and immediate effects on the general prosperity of Britain.

SIR GEORGE SUTTON gave an interesting address on Nov. 7, to the Royal Society of Arts, on "Fifty Years of British Industry." In particular, his remarks on the early days of the cable-making industry and the formation of the Cable Makers' Association (C.M.A.) were very instructive. There is nothing in the appearance of a high-grade cable for carrying heavy electric currents to distinguish it from a low-grade cable. If unregulated competition were allowed, then price would be the sole consideration, and this would rapidly bring about a deterioration of their quality. The leading firms therefore came together and formed an association, primarily for the purpose of adopting standards of dimensions and fixing the quality of the metal and the insulation. These standards are now recognised all over the world. The high factor of safety adopted enabled the cables to carry tremendous overloads during the War. The C.M.A. also extended its activities to regulating the field of com-

petition. Going on the assumption that the field was large enough for the growing prosperity of all its members, it formed what is disparagingly known as a 'ring.' However, the C.M.A. has demonstrated that it is possible for a number of firms entirely independent of one another financially to compete in effective service to the consumer and not by ruinous price competition. The research laboratories of the various cable manufacturers now pool their mental and material resources, and the overlapping of researches which formerly took place is largely prevented. The help of the National Physical Laboratory has proved of great value to them. So far as recruits for the industry is concerned, the employers want a combination of higher education with practical experience. Some colleges give this. Of late years there has been a notable increase in the employment of public school boys in industry. Their training fits them admirably in many ways for positions of control.

THE November number of *Naturæ Novitates*, published by R. Friedländer und Sohn, of Berlin, is of special interest as commemorating the fiftieth year of that bibliography and also the centenary of the existence of a firm to whose whole-hearted labours in the publication and distribution of scientific books and periodicals we all owe so much. R. Friedländer opened a bookshop in the Königstrasse in Berlin in 1828. The interest taken by the scientific men of the day soon caused him to confine his attention to scientific literature. At that time the work of Linnæus and others had led to the publication of a great many books on botany and zoology, and these were often expensive and difficult to obtain. Friedländer's first general catalogue of scientific books was issued in April 1836; his seventh catalogue dealt with natural history, and his eighth catalogue, published in 1847, covered the whole field of zoology. The firm began as R. Friedländer, but in 1851, when Dr. Julius Friedländer joined, it became R. Friedländer und Sohn. Julius was proficient in mathematics and physics. His knowledge of these subjects was of great assistance to the firm, which soon began to publish catalogues of scientific books at regular intervals. In 1878 he began the publication of *Naturæ Novitates*, a bibliographical periodical cataloguing scientific works as they appear. On the death of Dr. J. Friedländer in 1882, his former assistants, Ernst Buschbeck and Otto Budy, continued the work. At the present time the heads of the firm are Paul Budy, Dr. Kurt Budy, and J. R. Loewe, who will have the best wishes of all scientific workers for a happy and prosperous new century for the firm of R. Friedländer und Sohn.

THE inaugural series of Riddell Memorial Lectures, endowed anonymously in memory of the late Sir John Walker Buchanan-Riddell, was delivered before the University of Durham, by Prof. C. C. J. Webb, fellow of Oriel College, Oxford, and first Oriel professor of the philosophy of the Christian religion, on Nov. 28, 29, and 30 at Armstrong College, Newcastle-upon-Tyne. The general subject of the lectures was "Religion and the Thought of To-day." Modern European philosophy began with a criticism of a religious experience of a Christian type. Movements emphasising one-sidedly the 'universal' and the 'individual' aspects of reality have been checked by the discovery that the resulting positions were unable to do justice to essential facts of Christian religious experience. The position of religion in social life has changed within the last century and a half; and the attempt to find the religious values *within* instead of *beyond* this world and the civilisation which has been developed within it was characteristic of the nineteenth century and was assisted both by the rise of the idea of evolution and by the disintegration by biblical criticism of a purely authoritative conception of the Christian religion. The War, by inducing a revulsion of feeling as to the sufficiency of civilisation to satisfy the spiritual needs of men, brought about a reaction from the immanentism so marked in the religious thought of the preceding age; the problem of the immediate future is to secure the gains of that immanentism while recognising the need of a genuinely transcendent object of religion. The Christian doctrine of the nature of God affords a hint of a way in which these two aims may be reconciled.

LORD RAYLEIGH has been appointed a trustee of the Beit Memorial Fellowships for Medical Research in succession to the late Lord Haldane, who died on Aug. 19 last.

DELEGATES from forty nations recently attended in Paris an International Conference for the Limitation of Exhibitions, when a convention was signed agreeing to limit the number of general long-period exhibitions which are officially recognised to once in ten years at the least in the same country and once in two years at least in all countries. Special exhibitions confined to one trade or industry are limited less strictly. The convention does not apply to any exhibitions which do not seek official recognition or to sample fairs such as that of Lyons or the British Industries Fair. Great Britain was represented by Sir Edward Crowe, the new Comptroller-General of the Department of Overseas Trade; Mr. J. R. Cahill, of the British Embassy; and Lieut.-Col. Cole, of the Department of Overseas Trade. The delegates were accompanied by Mr. Guy Locock, of the F.B.I.; Mr. R. B. Dunwood, of the Association of British Chambers of Commerce; and by Mr. L. A. de L. Meredith, of the Department of Overseas Trade.

REFERRING to a note in our issue of Nov. 3, p. 707, a correspondent reminds us that Prof. Cossar Ewart discussed the question of the fertility of mules in a letter in NATURE of Nov. 24, 1910, p. 106, pointing out that either the true mulishness of the mother or the maternity of the foal was always in some doubt. Such uncertainty, however, does not seem to apply to the cases mentioned in our recent note.

WE regret that in a paragraph in our issue of Dec. 1, p. 854, on electrical equipment for X-ray apparatus, the name of the author of the paper was wrongly quoted. Mr. L. G. H. Sarsfield, the author of the paper in question, also points out that he preceded his remark on the future use of the induction coil for the highest voltage X-ray work with the qualifying

remark " it may be " ; the current rating of the small portable set mentioned is 10 milliamperes, not 10 microamperes.

THE leading article in last week's NATURE referred to a suggestion by Mr. J. B. S. Haldane that the Cabinet might contain at least one member with scientific knowledge. Mr. W. P. Dreaper reminds us that fifteen years ago, starting from the other end, he suggested that there should be a Science Committee in the House of Commons. As at present constituted, it would perhaps be difficult to form such a committee in the House, but as it has been stated that the time lag of all such changes is nineteen years, Mr. Dreaper hopes that his suggestion may come into effect in the next Parliament.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—An assistant master to teach mathematics in the Smethwick Junior Technical School—The Director of Education, 215 High Street, Smethwick (Dec. 10). A junior assistant under the Department of Scientific and Industrial Research, for work on plasters and other materials used for impressions and models in dentistry—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (Dec. 13). A laboratory assistant in the biology department of King's College of Household and Social Science —The Secretary, King's College of Household and Social Science, 61 Campden Hill Road, W.8 (Dec. 15). A physicist under the Australian Council for Scientific and Industrial Research, to take charge of seismic investigations in connexion with the Imperial Geophysical Experimental Survey—Mr. F. L. McDougall, Australia House, Strand, W.C.2 (Dec. 19). A temporary junior chemist at an Admiralty Inspection Establishment — The Secretary of the Admiralty (C.E. Branch), Whitehall, S.W.1 (Dec. 22). Junior assistants at the National Physical Laboratory, with qualifications in physics, electrical engineering or mechanical engineering — The Director, National Physical Laboratory, Teddington (Dec. 22). An expert in cattle breeding under the Egyptian Government, Ministry of Agriculture—The Royal Egyptian Legation, 75 South Audley Street, W.1 (Jan. 1). A professor of medicine in the University of Hong Kong—The Chief Medical Officer, Ministry of Health, Whitehall, S.W.1 (Jan. 7). Research workers at the Rowett Research Institute on, respectively, the nutrition of poultry and the nutrition of sheep—The Secretary, The Rowett Research Institute, Bucksburn, Aberdeen. A male technical assistant with honours in chemistry or physics, under the Chemical Warfare Research Department — The Chief Superintendent, Chemical Warfare Research Department, 14 Grosvenor Gardens, S.W.1.

Our Astronomical Column.

PUBLICATIONS OF BERGEDORF OBSERVATORY.—Bergedorf Observatory deserves the thanks of astronomers for the useful series of reference volumes that it is publishing. The G.F.H. or history of the fixed stars has been proceeding in instalments for several years. But that work does not contain observations made later than 1900 ; as large numbers of more recent catalogues have now accumulated, two volumes containing references to meridian observations made in the present century have just been published, dealing respectively with north and south declinations. Each volume has about 300 pages. The arrangement of the Durchmusterung is followed. The stars are grouped in degree of declination, the reference number of each star according to the Bonn or Cordoba D.M. ; then follow a pair of numbers ; the first number is the index denoting a catalogue ; 401 catalogues are listed at the end of each volume ; the second number is that borne by the star in the catalogue referred to. There are a considerable number of stars not contained in the D.M. ; these are given in separate lists, at the end of each degree of declination. Thus the material available for each star is shown at a glance.

Bergedorf has also produced a catalogue of its own, containing 4983 stars observed with the Repsold meridian-circle between the years 1913 and 1926. The classes of stars observed are those in Rumker's Hamburg catalogue that needed re-observation, stars with large proper motion, variable stars, comparison stars for planets or comets, etc. ; for example, Barnard's proper-motion star and some of its neighbours were observed in 1919. The catalogue bears the name of Dr. F. Dolberg, who did the whole of the observation at the telescope and a large part of the reductions.

THE TOTAL SOLAR ECLIPSE OF OCT. 22, 1930.—This eclipse has a track across the Pacific Ocean, but there are two islands within the belt of totality : Nurakita in the Ellice group, and Niuafou, some 280 miles south of Samoa. *Popular Astronomy* for October contains an article on Niuafou by Mr. Andrew Thomson, Director of the Apia Observatory. He was one of the observers from the United States of the eclipse of 1919 at Sobral, Brazil. Niuafou is a volcanic island about 3 miles in diameter. Mr. Ramsey, a trader on the island, is quoted as saying that landing would generally be practicable for packing cases of moderate size. There are 1100 inhabitants, and a Catholic mission has been there for many years. It is 8 miles from the central line, and totality will last 83 seconds, the sun's altitude being 52°. The weather statistics for Apia indicate the cloud ratio at 9 A.M. in October as 4·8, this being the same as the average for the whole year. 10 A.M. is about the clearest time of the day at Apia ; the local time of mid-eclipse is 9.9 A.M. Some expeditions to Niuafou have already been vaguely planned, but no definite arrangements have yet been made.

Predecessors of this eclipse in the Saros cycle occurred in 1858 and 1912, both being total in Brazil. The first was observed by Liais ; a Greenwich expedition went to the second but experienced cloudy weather.

NOVA IN MESSIER 33.—*I. A. U. Circular*, No. 211, announces the detection of a nova in this nebula by Dr. Baade at Bergedorf Observatory. It is 2′ preceding and 8′ south of the nucleus ; it is thus comparatively near the centre of the nebula, the diameter of which is about 1°. The magnitude of the nova is 16·0, which on Hubble's value for the distance of the nebula (870,000 light years), gives an absolute magnitude of − 6. Novæ in the spirals have been discovered in considerable numbers, there being 67 in the Andromeda nebula between 1909 and 1926. The discovery of the present nova was presumably effected with the large reflector at Bergedorf, which has proved so efficient in the detection of very faint comets.

Research Items.

EXCAVATIONS IN THE PIN HOLE CAVE, CRESWELL.—In a paper read before the Royal Anthropological Institute on Nov. 20, Mr. A. Leslie Armstrong described the work proceeding in the large inner chamber of this cave. The total depth of the deposit is 15 feet and consists of an upper and a lower cave-earth. Evidences of casual human occupation occur throughout the upper cave-earth and the dominant culture has been proved to be Upper Aurignacian with considerable Proto-Solutrean elements and some traces of intrusive Magdalenian near the top. Upper Mousterian artefacts of quartzite and flint occur at the extreme base. A recent find of outstanding importance to English archæology is that of an engraved drawing of a masked human figure, executed upon a rib, probably of a reindeer. In general character and technique the figure resembles those of Hornos and Altamira, which are of Aurignacian date. It was found in association with Proto-Solutrean implements and was encrusted with breccia. The present specimen is the first Palæolithic drawing of a human figure to be found in Britain, and, being of a type which is rare even in the rich caves of France and Spain, it is of the greatest scientific interest. The engraving was found beneath stalagmite, 3 feet 6 inches below the floor of the cave, on an ancient occupation level, together with Proto-Solutrean and Aurignacian flint implements, and is therefore attributable to the dawn of cave art. The lower cave-earth contains two definite zones of occupation, the lowest at 12 feet. Implements of quartzite and tools of bone and mammoth ivory occur in both zones, the technique of which is Mousterian. Evidence of submergence of the lower cave-earth on two occasions and of climatic changes are well marked, and the occupation zones are separated by sterile layers of fallen roof slabs.

BIRDS AT SEA.—It is well known that in tropical seas many strong fliers amongst birds, such as frigate-birds, spend the greater part of their life at sea far from land, but it is interesting to learn that even in far northern waters there is also a goodly bird population far from the shore. During a voyage along an unusually far northern route—to Greenland—E. M. Nicholson made several counts over 10 sea miles, at distances about 300 miles from land (*British Birds*, November). They yielded numbers varying from 34 to 170 birds, leaving the impression that the oceanic bird population in about 60° N. lat. ranged from 5 to 10 per square mile. The majority of the birds observed were great shearwaters, fulmar petrels, and, in lesser numbers, terns and puffins.

VARIATION AND CORRELATION.—Messrs. W. W. Alpatov and A. M. Boschko-Stepanenko have made a study of variation and correlation in certain serial organs of insects, birds, and fishes (*Amer. Naturalist*, Oct. 1928). In the Hemipteran *Pyrrhocoris apterus* the biometrical constants for length of joints in the antennæ were determined. The length of the phalanges was studied in the raven, the goose (*Anser albifrons*), collected on Novaya Zemlya, and in domestic fowls from Central Russia. The fish was *Boreogadus saida* from Barents Sea, which has several dorsal fins. A relation was found between absolute size and variability in fin characters, the larger ones being less variable. The wild birds were also less variable than the domestic ones. Pearson's 'rule of neighbourhood' concerning the intercorrelations of serial organs was found to hold in nearly every case.

MUSSEL GROWTH IN SUBMARINE SHAFTS AND TUNNELS.—An interesting report by Dr. James Ritchie, dealing with this subject, appears in the *Transactions of the Royal Scottish Society of Arts*, vol. 19, 1914–25 (Edinburgh, 1927). In 1919, before erecting the new Electricity Generating Station at Portobello, the Committee of Edinburgh Town Council and its consulting engineers foresaw that difficulties might arise from the accumulation of mussels and other organisms in the large tunnels through which water for condensing purposes was to be conducted from the sea. Dr. Ritchie was then asked to carry out experiments in order to prevent such growth, the research, carried on over a period of two years, resulting in the discovery of a successful method of dealing with the obstruction. Whilst other organisms were liable to accumulate in the tunnels, the mussels only were of considerable importance, and it was shown by preliminary experiments that these certainly could accumulate to such an extent as to interfere in no small degree with the flow of water. The mussels enter in the free-swimming larval stage and settle down when only $\frac{1}{75}$ of an inch long, therefore it is practically impossible to prevent their entry. A way had to be found which killed them when once in the tunnel. Dr. Ritchie has now found a suitable method which consists in sending a reversed current or outflow of heated sea water into the tunnels and shafts at stated intervals, at such a temperature and for such a time that all the young mussels will be killed. A suitable minimum temperature is 110° F., the current to be passed through every four weeks during the spatting season, reckoned from the beginning of March until the end of October. These measures have proved to be very effective and have resulted in the entire clearance of the larger mussels from the tunnel. In practice, the raising of the temperature to such a height has proved to be expensive, therefore the alternative method of raising the temperature to 90° F. for a longer period has been adopted.

SEA-URCHINS OF THE INDIAN OCEAN.—An account of the Regular Echinoids forms the third and concluding part of Prof. R. Koehler's memoir on the Echinoidea of the Indian Museum, Calcutta. This part was, says Prof. Koehler, ready in manuscript in 1922; it bears the date of publication, November 1927, but was not received by us until the end of last October. It describes some 50 species, of which 14 are new, and two of these represent new genera, namely, *Printechinus* in the Temnopleuridæ, and *Prymnechinus* in the Echinidæ. An appendix describes two prosobranchiate gastropods parasitic on some of the Echinoids. They belong to the family Eulimidæ, many members of which are already known to infest various Echinoderms. One of them is a *Mucronalia* which settles on an ambulacrum of a *Stereocidaris* and extends its proboscis through one of the pores for the tube-feet; this gives rise to many anomalies in the structure of the test. The mollusc is readily shaken off the test, leaving little direct trace, and it may be that some abnormal Echinoids, both recent and fossil, which have been described, may have owed their peculiarities to a similar cause. The other parasite, which belongs to the allied genus *Megadenus*, is quite small, and lives on a *Dorocidaris*. It attacks one of the main radioles while the urchin is still young, checks the normal growth of the radiole, and becomes enveloped in a gall-like thickening, usually with an opening through which the spire of

the tiny shell can be seen. This shell is that of a female; but in the same cavity there also lodges a yet smaller male. This then represents a stage on the way to the dwarf rudimentary males already known in the Endoparasitic gastropod *Entocolax*.

'DIE-BACK' OF PLUM TREES A BACTERIAL DISEASE.—For many years growers have noticed the occurrence of stunted shoot growth in plum and cherry trees, with foliage pale in colour which withers or falls prematurely. Such 'die-back' has been described as due in many cases to a fungus *Diaporthe perniciosa*, which has been very fully examined by Miss Cayley (*Ann. Applied Biology*, **10**, No. 2; 1923). Mr. H. Wormald has had a disease of this type under observation amongst the plum trees in the experimental plots at East Malling. Fungus fructifications often appeared upon the dead bark in the diseased region, but Wormald noticed that numerous bacteria were often present at the upper and lower limits of the diseased area. This aroused suspicion that the fungi might be a secondary result, and that the causal agent in producing the disease might be bacterial in nature. Isolation and cultural experiments were therefore carried out with the bacteria, and subsequent inoculation experiments with the cultured organism supply evidence that these bacteria can in many cases produce 'die-back' as the result of their introduction through a wound. These observations are briefly described in the *Gardener's Chronicle* for Nov. 10.

PROPAGATION OF RUBBER PLANTS.—A little while ago, the Right Hon. W. Ormsby Gore placed some very interesting data before the fellows of the Royal Colonial Institute, which are reproduced in *Tropical Life* for November 1928. In the old Botanical Gardens of Ceylon, at Heneratgoda, is a group of rubber trees which have been grown from the original seed brought by Sir Henry Wickham from the Amazon. Amongst them is a famous tree which, over a continuous period of five years, gave an average annual yield of 96 lb. of dry rubber. The average annual yield per tree on an ordinary plantation is about 4 lb. Unfortunately, seedlings from the high yielding tree have not possessed a yielding capacity much above the average, and the only possible method to obtain a plantation of high yield from a single plant with these qualities would appear to be by some method of vegetative propagation. Cuttings do not root successfully, so that bud grafting, now practised for some time in the Dutch plantations of Java and Sumatra, seems worthy of very extensive trial in British rubber-growing plantations. Planting Manual No. 2 of the Rubber Research Institute of Malaya (Kuala Lumpur, 1928), which contains an account of the budding of *Hevea* in modern plantation practice by Dr. Summers, is therefore a very timely publication. Dr. Summers makes it clear that the evidence at present available does not justify a complete abandonment of seedling propagation in favour of the new method. Mr. Ashplant has recently claimed (NATURE, June 30, p. 1018; *Tropical Life*, November 1928) that yield of latex is closely correlated with the diameter of the latex tube as determined under certain specified conditions, and states that by this method a reliable guide to future yield is provided which can be employed upon six-month-old seedlings. If further work should substantiate this claim, it may yet be possible to select seedlings of high yielding trees from the nursery beds and build up a plantation of high average yield from seedlings even more easily than from vegetatively propagated clones.

GOLD COAST SURVEYS.—The annual report of the Survey Department of the Gold Coast for 1927-28 shows that the topographical map is nearly complete from the coast to lat. 7° N. The necessity of concentrating work on boundary surveys delayed topographical work during the year. The western boundary is nearly completed, and the eastern, which is the division between British and French mandated territory in the former Togoland, is making good progress. The new survey school at Accra is growing, and turning out annually a number of competent surveyors.

MAGNETIC MAP OF ENGLAND AND WALES.—The Ordnance Survey has published a layer coloured orographical map of England and Wales on a scale of 1 to 1,000,000 on which the lines of equal magnetic variation are drawn at 15-minute intervals (Southampton: Ordnance Survey. 2*s*.). Their approximate courses in the English Channel and the Irish Sea are also shown. The position of magnetic observatories is also clearly shown, with the value of each station for the year 1927. No other names except those of physical features are given. The map is a fine example of colour printing and clear typography.

GEOLOGY OF THE SALT RANGE.—A first-hand contribution to the geology of the Punjab Salt Range is published by Dr. C. S. Fox in the *Records Geol. Surv. India*, p. 147, 1928. In recent years the hypothesis of a Tertiary age for the salt, and of considerable thrust faulting in the Range itself, have been fashionable; Dr. Fox, however, returns to the view already advocated by Murray Stuart that the Saline series lies beneath beds of Cambrian age, and that the Kohat deposits are probably of the same age. He shows that the Tertiary deposits do not provide any evidence of deserts, or of any period of desiccation. On the other hand, the Cambrian beds suggest a prolonged period of arid conditions over a very wide area during which the salt beds could readily have been formed. Similar beds in Persia—also associated with similar volcanic material—are considered to be of Cambrian age, and to belong to the same climatic province. The anomalous position of the salt marl in the Salt Range can be easily and satisfactorily accounted for by simple solution and isostatic settling, while the foliated character of the Kohat salt is a consequence of flowage under the great pressures accompanying mountain folding.

CLIMATE OF JAVA.—The Royal Meteorological and Magnetical Observatory of Batavia continues its publications on the climate of the Dutch East Indies. In the most recent (*Verhandelingen*, No. 6) Dr. C. Braak deals with the climate of Java and Madura. The volume is in Dutch, with a lengthy summary in English. It includes a number of photographs of cloud forms, and two maps showing the wind direction during the east and west monsoons. After a general account of the winds there follows a description of the climate of certain places that have characteristic features. For other stations the full data will be given in the statistical volumes which have yet to be published. Sumatra was treated in a previous volume, which contained a general account of the rainfall. Java contrasts with Sumatra in having a sharp distinction between the wet and dry season. In east and much of central Java there is a rainless season of several months. In west Java this is marked only in exceptional years. Another peculiarity of east and central Java is the persistence of the föhn winds during the dry season. Night frosts occur in Java at great heights. These are unknown in Sumatra. They occasionally do considerable damage to plantations.

ATMOSPHERIC POLLUTION.—The work of the Meteorological Office Advisory Committee on Atmospheric

Pollution was transferred to the Department of Scientific and Industrial Research last year. That Department is responsible for the thirteenth report on observations of atmospheric pollution, although it deals with observations made in the year ending March 1927, prior to the transfer and reorganisation. The form of the report remains unaltered. It includes among several other studies of more than theoretical interest, an analysis of the deposit of atmospheric impurity at eighty different stations in the British Isles, which reveals the fact that between 1914 and 1927 the percentage of stations falling within the two categories with least deposit out of the four into which the range of pollution is divided, has increased from 15 to 87 per cent. It appears that for carbonaceous matter Newcastle-on-Tyne gives the highest figure, while for sulphates Burnley heads the list. In spite of the general improvement, the small percentage of stations in the class with the largest deposit remain unaltered at the end of the period under review. The general conclusion that appears to emerge from these statistics, and from a more detailed study of the relative proportions of carbonaceous pollution and of that due to sulphates, is that in the industrial regions where impurity is derived largely from factory smoke, any improvement is very small compared with the change in residential districts, where the increasing use of gas fires in place of the open hearth makes itself increasingly felt. The report concludes with a short study of the relationship between the degree of impurity of the air in London and the figure for ultra-violet light derived by Dr. Leonard Hill's acetone blue method. This shows that the amount of ultra-violet light received becomes so sensitive to the degree of impurity over a certain range of the scale for impurity, that the fixing of a standard for what may be regarded as hygienically 'clean' air will probably not prove difficult.

AN ELECTRICAL MODEL OF THE HEART.—Some two years ago, Dr. B. van der Pol suggested that the heart-beat was a biological example of the so-called relaxation oscillations the properties of which he had been studying. This idea has now been developed in detail by him and J. van der Mark in a paper which appears in the supplementary November number of the *Philosophical Magazine*. The mathematical treatment of the electrical circuits used in illustration of the theory is involved, but they are essentially systems in which a decay phenomenon repeats itself, the terms in the equations corresponding to the resistance term for mechanical motions being negative for small amplitudes, instead of positive, as is usually the case. The sinus, the two auricles, and the two ventricles are represented respectively by three flashing neon lamps, which are connected in such a way that the order of discharge is that which occurs in the natural heart; the link between the auricles and ventricles—the bundle of His—is another neon lamp. Electro-cardiograms have been taken from the model, and are similar to those of a natural heart, showing not only the main features of the normal beat, but also, when the appropriate additional stimuli are applied, such phenomena as auricular and ventricular extra-systole, partial and complete heart block, and the refractory period. Of special interest is the reproduction of the biological law of 'all or nothing': a stimulus has either no effect at all, or it causes the complete response. The success of their model has prompted the authors to predict from it a number of new phenomena which might be met with in the natural heart, and they state that by elaborating it in another direction they have arrived at a model of a striated muscle upon which they hope to report later.

DETERMINATION OF CELLULOSE BY OXIDATION WITH CHROMIC ACID.—In the cellulose industries the problem of determining the amount of cellulose in a solution containing no other organic material frequently arises. The method of precipitation of the cellulose followed by direct weighing is tedious, and it is much quicker to effect the quantitative oxidation of the material to carbon dioxide and water by means of a mixture of chromic and sulphuric or phosphoric acids. The latter method is described in detail by Constance Birtwell and B. P. Ridge in the *Journal of the Textile Institute* for October. The use of phosphoric acid instead of sulphuric acid is to be preferred, unless the cellulose content of the solution is very low, in order to avoid the possible formation of sulphur dioxide. Instead of measuring the volume of carbon dioxide formed, the amount of chromic acid used may be determined by titration.

GLYCERIN.—The *Journal of the Society of Chemical Industry* for Oct. 19 contains an interesting account by W. F. Darke and E. Lewis of the methods of manufacture and applications of glycerin and some of its substitutes. The chief sources of glycerin are oils and fats, which on saponification yield glycerin and soap or fatty acids. During the War, glycerin was made in Germany by the fermentation of beet sugar, but this and various synthetic processes that have been suggested are not now employed. In medical and pharmaceutical practice, glycerin is used on account of its softening action on the skin, its solvent properties, and especially because of its antiseptic powers. It destroys bacteria much more rapidly than tissue cells, and should therefore be of great value in surgery. It also forms a constituent of certain infant and invalid foods. The industrial uses of glycerin depend chiefly upon the low freezing point of its aqueous solution and its dehydrating properties, although large quantities are consumed in the explosive, adhesive, and ink industries. Many substances have been proposed as glycerin substitutes, such as magnesium butyrate, but their application is limited. Ethylene glycol is sometimes used in place of glycerin as an anti-freeze medium and as a lacquer solvent, but its production is more costly.

DETERMINATION OF PENTOSANS. — The classic method for the determination of pentosans, due to Tollens, and consisting in distilling the material with hydrochloric acid of density 1·06 and weighing the furfuraldehyde thus formed as phloroglucide, is known to be subject to various sources of error. In the *Rendiconti del Reale Instituto Lombardo di Scienze e Lettere*, Parts 6-10 (1928), Dr. C. Antoniani gives the results of experiments made to ascertain the extent to which the values obtained by this method are influenced by the presence of carbohydrates with a 6-carbon atom basis. In the case of fodder, the effects of hexoses or hexosans are not, as a rule, sufficiently large to invalidate the conclusions drawn from the pentosan content with regard to the value of the fodder. From the purely analytical point of view, such admixtures do, however, exert an influence, this being least for cellulose and appreciably greater for starch and hexoses in general. The discrepancies are due, only in slight degree, to the formation of extra quantities of furfural, and depend mainly on the presence in the distillate of hydroxymethylfurfural, which is derived from the dehydration of the hexoses and is, under the conditions employed, only partially converted into levulinic acid. This hydroxy-compound may be removed by redistillation of the first distillate, but allowance must then be made for the diminution of the furfural originally present by 7 per cent. The experimental results indicate that the furfuraldehyde phloroglucide obtained is not always of exactly the same composition.

Anniversary Meeting of the Royal Society.

THE anniversary meeting of the Royal Society was held on Nov. 30, and in his presidential address Sir Ernest Rutherford referred to the Society's loss by death during the past year of two foreign members, thirteen fellows, and two fellows who were elected under Statute 12, which provides for the election of persons who have rendered conspicuous service to science, or whose election would be of signal benefit to the Society. He also reviewed the work of the three Yarrow and two Foulerton professors who have been appointed since 1923, and announced that the Council has decided to fill the Foulerton chair vacant through the death of Prof. E. H. Starling. Dr. E. D. Adrian, lecturer in physiology in the University of Cambridge, has accordingly been appointed. With the aid of apparatus using electrical amplification, Dr. Adrian has been engaged in recording and analysing the minute changes transmitted, from an excited peripheral sense-organ, along the conducting system of the nerves—changes which, on arrival at a nerve-centre in the brain of a conscious being, would result in one or another form of sensation.

Sir Ernest Rutherford then gave an account of recent work on high frequency radiation, which appears elsewhere in this issue. The presentation of medals followed, and we print below extracts from the descriptions of the work of the medallists.

Presentation of Medals.

The Copley Medal, awarded to Sir Charles Parsons.

In the world of mechanical engineering the genius of Charles Parsons has opened up a new era. He has originated and developed a new type of thermal engine entirely flexible and adaptable, and capable of high efficiency combined with concentration of power never even imagined before. By continuous practical effort for the past forty-five years, aided by remarkable mathematical insight acquired in his university days, he has perfected the parallel-flow compound steam turbine, and has applied it successfully to electric generation and to marine propulsion, both attaining to an unprecedented scale. While the utilisation of heat in the best triple-expansion reciprocating steam engine amounts to 17 per cent of the whole, the Parsons' large central station turbines now convert 25 per cent into mechanical power, and in still larger turbines 28 per cent is anticipated. The first steam turbine of 4 kilowatts was used in 1885 for electric lighting; at present, turbines of 20,000 and 30,000 kilowatts are in operation. The application to marine propulsion was signalised in 1897 by the appearance of the *Turbinia*, a small experimental craft developing the extraordinary speed of 33 knots. Large turbine-driven destroyers for the Navy rapidly followed, and now all large high-speed liners are turbine driven. During this remarkable development numerous problems arose involving a precise study of jet velocities, leakage, turbulent flow, and vacuum augmenters. The phenomena involving cavitation of screw propellers opened up new fields of abstract as well as practical interest. Sir Charles Parsons has been greater in the scientific development of thermal power produced by steam than any engineer since James Watt. A recent side product of his activities has been the revival of the British scientific industry of optical glass and telescopic construction, while some of his hours of relaxation have been spent in the strenuous endeavour to crystallise carbon into diamonds by catastrophic processes.

The Rumford Medal, awarded to Prof. Friedrich Paschen.

Prof. Paschen is especially distinguished for his practical and theoretical contributions to spectroscopy. He early acquired remarkable skill in the investigation of infra-red radiation and made valuable determinations of the distribution of energy in the spectrum of a black body, giving the first experimental proof of the law that the frequency of maximum energy is proportional to the absolute temperature. He afterwards made numerous observations of the infra-red emission spectra of various elements, which were of fundamental importance for the development of our knowledge of series in spectra, and afterwards for the theory of spectra in relation to atomic structure. He has also contributed in a notable degree to the precise measurement and series classification of spectrum lines in general; he has long been one of the foremost workers on the Zeeman effect, and the results which he has obtained, including the discovery of the well-known Paschen-Back effect, have been invaluable for theoretical discussions. He has shown extraordinary skill in the design and manipulation of apparatus, and his work is characterised by an obvious striving for the greatest attainable precision.

A Royal Medal, awarded to Prof. Arthur Stanley Eddington.

Prof. Eddington's contributions to knowledge within the past ten years have been mainly in connexion with the internal constitution of stars and with the generalised theory of relativity. He has formulated a complete theory of the internal structure of a star, assumed to be a non-rotating whirl of atoms and electrons, with radiation gradually forcing its way to the surface; further, he pointed out that the masses of stars, which are found by observation not to vary greatly, ranged about the point where radiation pressure balances gravitation. Later, he obtained a theoretical relation between the mass and absolute luminosity of giant stars. Prof. Eddington has also worked out a mathematical theory of Cepheid variables on the assumption that they are oscillating radially. In connexion with the theory of relativity, he conducted in 1919 one of the two eclipse expeditions which verified the deflection of light rays from stars near the sun. He also developed the theory, to a certain extent on the philosophical side, but considerably on the analytical side, especially with regard to the electromagnetic and gravitational fields.

A Royal Medal, awarded to Dr. Robert Broom.

During the course of thirty-three years' search in Australia and South Africa, Dr. Broom has made a very large number of important discoveries in vertebrate palæontology, embryology, and morphology that shed new light upon the problems of the origin of mammals, lizards, crocodiles, and birds. His researches represent the most significant contribution made by any one investigator to the determination of the relationships of the main groups of vertebrate animals and to the definition and solution of the problems involved in the evolution of the higher groups.

The Davy Medal, awarded to Prof. Frederick George Donnan.

Prof. Donnan is, like his master van 't Hoff, a man of ideas. Early in his scientific career he wrote on

the nature of soap emulsions and on the theory of capillarity and colloidal solutions. His theory of membrane equilibrium and membrane potential is an achievement of the first rank, and has been the starting-point of numerous studies not only in the domain of pure chemistry, but more especially in biochemistry, where the conditions for displaying the phenomena he predicted are often encountered. His researches on surface tension and absorption at liquid-liquid interfaces have led to results of the greatest interest, and his verification by means of nonylic acid of the Gibbs' absorption formula is a most brilliant experimental conception. A by-product of his activities during the War is a theory of the action of gas-scrubbers, based on the velocity of absorption of gases by liquids.

The Darwin Medal, awarded to Dr. Leonard Cockayne.

A true naturalist, Dr. Cockayne has waited patiently upon facts before drawing conclusions. For more than thirty years he has made it his task to deepen and widen our knowledge of New Zealand botany in the broadest sense. He is one of the foremost living students of plant-association ; the taxonomic studies rendered necessary by his ecological results have led to those remarkable discoveries of natural hybrids in New Zealand that have won for him a world-wide reputation and have made on modern thought an impression akin to that produced by the results of Darwin's studies of plants under domestication. Dr. Cockayne's researches have had, on sylvicultural and agricultural procedure, a practical bearing which has been appreciated by, and has influenced the policy of, New Zealand statesmen.

The Sylvester Medal, awarded to Prof. William Henry Young.

Dr. W. H. Young has taken a very prominent part in the development of the modern theory of functions of real variables, and in its application to the theory of Fourier's and other series. His earlier work dealt chiefly with the theory of sets of points, and contains important developments on the lines laid down by G. Cantor and Harnack. He soon preceeded to apply this theory in the integral calculus, and he obtained a general definition of the integral which is essentially equivalent to, although somewhat less simple in form, that given about the same time by H. Lebesgue, which latter has become a corner stone of modern analysis. Much of Dr. Young's work has proved to be a starting point for further investigations by other mathematicians. By means of his conception of restricted Fourier's series he was enabled to devise a method by which conditions of convergence, summability, etc., known to hold good for Fourier's series, could be carried over to series of Legendre's and Bessel's functions.

The Hughes Medal, awarded to M. Le Duc de Broglie.

Maurice François César, Duc de Broglie, is distinguished especially for his pioneer researches on X-ray spectra and secondary β-rays. He was one of the first to obtain the complete emission spectrum of X-rays and to study X-ray absorption spectra, while his work on the magnetic spectrum of the β-rays, arising from the passage of X-rays through matter, has proved of great importance. He founded in Paris a private laboratory directed by himself, which is devoted to researches on X-rays and allied subjects.

Applied Chemistry.

Physical Chemistry and Biology.

THE first Liversidge lecture was delivered before the Chemical Society on Nov. 29 by Prof. F. G. Donnan, who discussed the applications of physical chemistry in the service of biology. In connexion with similar lectures to be provided by the University of Sydney, the Royal Society of New South Wales, and the Australasian Association for the Advancement of Science, this series of annual lectures has been established by the Chemical Society in accordance with the terms of a bequest by the late Prof. Liversidge, of the University of Sydney, a bequest which was made with the object of stimulating thought and encouraging the acquisition of new knowledge. Liversidge lectures delivered before the Chemical Society will be concerned with physical and inorganic chemistry, whilst another series of lectures, perpetuating the memory of the late Sir Alexander Pedler, will deal similarly with organic chemistry.

Prof. Donnan first referred briefly to the part played by organic and inorganic chemistry in the advancement of biology. Physical chemistry, as created by Raoult, van 't Hoff, Ostwald, Arrhenius, and Nernst, first began to exert a powerful influence on biology, although no period in the development of physical chemistry clearly marked the beginning of the application of that science to biological problems. The osmotic theory of semi-permeable membranes, based on the work of Pfeffer and van 't Hoff, was of exceptional importance in its explanation of the then mysterious vital action of the living cell. The triumph and development of the ionic theory has revolutionised a large part of the theory of solutions, and has been of correspondingly fundamental importance in the study of essential constituents of the living organism ; the hydrogen ion activity determines the molecular state and colloidal condition of the amphoteric proteins in aqueous solution, and the optimum activity of enzymes. It is not surprising, therefore, that the delicate dynamic equilibrium of living protoplasm requires a close regulation of the hydrogen ion concentration, determinable by known or theoretically calculable ionic equilibria.

Prof. Donnan also referred during his discourse to the great biological importance of the thermodynamical studies of Willard Gibbs, to whom we owe very important considerations relating to surfaces of separation between different media. There exist at such surfaces powerful uncompensated fields of atomic and molecular forces, as a result of which molecules and ions are held or adsorbed in spite of general thermal agitation tending to disperse them. Some of the forces may be of considerable extent, and perhaps considerable symmetry, whilst others are highly localised ; the latter are of great importance since they cause the orientation and regular arraying of molecules and ions at surfaces and surface films. "A living cell," said Prof. Donnan, "is not merely a little bag containing salts, proteins, sugars, fats, and enzymes in which chemical reactions occur as in a beaker or flask. There is organisation, and organisation in space means arrangement. In this orientation and arraying of molecules and ions at surfaces we may perceive, perhaps, the first faint glimmering of the organised arrangement of life's mechanism."

Finally, Prof. Donnan referred to three considerations of major significance which must be taken into account. First, that the laws of thermodynamics, being statistical in their nature, do not necessarily

apply universally in very small systems. Further, that modern quantum mechanics appears to provide for the recently postulated inexpressibility of the whole in terms of its parts. Again, that the determinism which is associated with Newtonian philosophy is now being rejected in favour of a less materialistic science. In a recent book, Prof. Eddington has shown that a particle may have position or velocity, but not both; it follows, therefore, that prediction of the future is a statistical problem. Modern science tends to acknowledge the element of volition.

CHEMICAL ENGINEERING.

Chemical engineering education and research in Great Britain, a matter which is of exceptional importance in the post-War development of British industry, formed the subject of the inaugural lecture delivered by Prof. W. E. Gibbs at University College, London, on Dec. 3. The age has passed when coal, for example, was regarded simply as a convenient combustible or as a raw material from which gas, coke, tar, and smoke can be obtained; the chemist to-day is altering the whole basis of coal valuation. Likewise, as Prof. Gibbs pointed out, the atmosphere has become a source of ammonia and nitric acid, as well as of oxygen; wood is being transformed into a variety of products in which we can no longer recognise the original material—paper, artificial silk, plastics, lacquers, sugar, and alcohol; waste products such as casein have provided the foundation of new industries.

Whereas the pioneering work connected with the establishment of new chemical industries—new reservoirs of national power and prosperity—and the better equipment of existing industries in the face of world-competition has its origin in the laboratory, it must be realised that the problems and difficulties that arise in a works, and may threaten not only economic success, but also the very practicability of a manufacturing process, are entirely different from those encountered in a laboratory. The successful transformation from the experimental to the commercial scale requires not only a sound understanding of the scientific principles which are being employed in a chemical reaction, but also it demands more than casual acquaintance with the theory and practice of civil, mechanical, and electrical engineering, with the control of labour, with the financial returns, and with market conditions and requirements. Such matters properly belong to the newly developing science of chemical engineering—a distinct and separate branch of science with its own problems, its own methods, and its own opportunities.

Prof. Gibbs stated the case for the specialised training of chemical engineers very simply as follows: "An industrial chemical process is at heart a chemical reaction, but the reaction is hidden away in an elaborate arrangement of plant and machinery. The engineer can generally fathom the meaning of the machinery, but the reaction baffles him. The chemist can understand the reaction if only he can find out where it is going on. Neither understands the complete process, nor can they together grasp it completely. For there is much in an industrial chemical process which only occurs when the work of the chemist and the work of the engineer are brought together. It has become necessary, therefore, to train men who shall be able to see the process as a whole. . . . This is the function of the chemical engineer."

Prof. Gibbs did not, however, disparage the work of those who, because of unusual opportunities, or as the result of long apprenticeship, have developed without specialised instruction into exceedingly able engineers; but he declared that the supply of able men from this source is, from the point of view of present needs, too slow and uncertain. He described in some detail the type of work which, in modern chemical industry, requires the co-ordinated knowledge and experience which is being made available, for example, at University College and the Imperial College of Science and Technology. The product which they aim at producing is (quoting from his predecessor, Dr. E. C. Williams) "a scientific man whose duty it is to plan the large-scale commercial operation of chemical processes, and to design and operate the plant required for the carrying out of the chemical reactions and physical changes involved."

The chemical engineer is not concerned with the original research, which is in the domain of the laboratory chemist, or with the construction of the plant, which is the business of the engineer. The chemical engineer should know when to sacrifice chemical efficiency to economic efficiency. He would of course have opportunities of original investigation in studying the peculiar problems that arise during the operation of a process.

Moreover, there are many problems concerning the physical and chemical behaviour of new structural materials, and of old materials under new conditions, that await solution. We require much more information concerning, for example, heat transfer through dividing walls, the power absorbed in transporting powders through pipe lines, the production of crystals from gases and liquids, the flocculation of fogs and smokes, the adsorption of vapours, and the behaviour of colloidal substances in large quantities. It is clearly desirable that chemical employers and chemical plant manufacturers should either undertake or endow research with the view of the acquisition of fundamental data, as well as the elucidation of specific problems.

University and Educational Intelligence.

CAMBRIDGE.—Mr. A. F. R. Wollaston has been re-elected fellow and tutor of King's College. Prof. S. Chapman has been appointed Rouse Ball lecturer in mathematics for the present year. Mr. A. S. Besicovitch has been appointed Cayley lecturer in mathematics. The Arnold Gerstenberg Studentship has been awarded to C. H. Waddington, Sidney Sussex College. The Raymond Horton-Smith Prize has been awarded to H. Gainsborough, Downing College, for his work on "So-called Lipoid Nephrosis"; *proxime accessit*, E. G. Holmes, Christ's College, whose subject was "Metabolism of Nervous Tissue."

The Court of the Goldsmiths' Company has resolved that "in view of the close association between the company and the metallurgical department at Cambridge, and in view of the distinguished work carried out by Mr. C. T. Heycock, F.R.S., during his tenure of the readership (from which he has just retired)," it will transfer ultimately a capital sum of £10,000 to increase the endowment of the Goldsmiths' readership in metallurgy.

A SCIENTIFIC research fellowship is being offered by Girton College, Cambridge, for research in mathematical, physical, and natural sciences, including engineering, medicine, and agriculture. The fellowship will be of the annual value of £300 and tenable for three years. Particulars are obtainable from the Secretary of the College, to whom applications should be sent on or before Feb. 1 next.

Calendar of Customs and Festivals.

ADDENDA.

Two feasts observed in Macedonia during the month of November may be noted for their bearing on the ecclesiastical calendar and popular belief.

November 18.

The feast of St. Plato the Martyr, which has been translated in popular speech into St. Plane Tree (Πλάτωνος—ἀι Πλάτανος). This is an important date in weather lore, especially on the coast, for not only is this holy day said to witness all kinds of weather, but also the weather at sundown will last through all the forty days of Advent.

November 21.

THE FEAST OF THE VIRGIN.—The month of November is known as the "Sower" (Σποριάς) and the Virgin is known as the "Patroness of the Seed-Time" (Ξεσπορίτισσα), a very interesting attribution which directly identifies the Madonna as a fertility goddess.

December 12.

ST. FINNAN.—Confessor and Bishop of Clonard in Ireland in the sixth century. The day on which he is venerated, now fixed as Dec. 12, was in the Highlands of Scotland formerly celebrated on the shortest day of the year. The eve, being the longest night, was spent in festivities. It was a favourite occasion for playing tricks on children. They were told that on this night the rain is wine and the stones are cheese. They were sent out to watch for the transformation or to sip water from a tub until it is turned to wine—a trick which preserved vaguely a belief in magical forces operative on one of the most critical occasions of the year.

ST. CORENTIN, Bishop of Quimper, probably in the fifth century. The son of a British nobleman, he is said to have retired to a forest in the parish of Ploumadiern, where he passed several years in solitude. The association of his cult with Quimper brings it into relation with earlier belief, for not only was it the religious centre of that part of Brittany which maintained its independence of Clovis and his successors, but also as "the place of the meeting of the rivers," it was an important centre of Breton cult, while the Counts of Cornouailles, one of whom is said to have given his palace at Quimper to the Bishop, were themselves in legend connected with the cult of a sea and river goddess. The cult of a Corentin or Cury also appears in Devon and Cornwall as a hermit at the foot of a hill Menehent.

December 14.

ST. TIBBA'S DAY.—A day which was at one time devoted by the fowlers and falconers of Rutlandshire to the veneration of this saint, whom they regarded as their patroness. St. Tibba and her cousin St. Eabba were in early life passionately devoted to the pursuit of hunting, but afterwards became saints. Ryhill in Rutlandshire was the centre of the cult, and Camden says that this superstition prevailed among the people to such an extent as to make them forgetful of the true god in their devotion to this pagan goddess, a kind of Diana.

The remains of St. Tibba were translated to Peterborough Cathedral, and the true character of her shrine and sacred well were forgotten, the latter in local legend becoming associated with a queen who used to climb the hill and bathe in the spring daily. Its name, from St. Tibba's Well, was corrupted into Stibba's Hill Well. Anniversary meetings were once held on the brow of the hill at Halegreen, a name said to be derived from the solemnities once enacted there, and evidently therefore a traditional place of some early religious ceremonial. The memory of St. Eabba is preserved in the corrupted form of Staplesford (St. Eabba's Ford) Bridge above Ryhill, where was situated a well once sacred to her but afterwards known to shepherds as St. Jacob's Well. The association of a goddess of the ford, *i.e.* of the river, with hunting, is worthy of note.

THE GROWTH OF RITUAL IN INDIA.—Beliefs and ritual practices connected with agriculture among the peasant population of India not only serve to throw light upon the development of a number of general religious ideas, but also illustrate or elucidate some of the more primitive survivals among the European peasantry.

In the Karnatak, the plough is worshipped before it is taken to the fields, and the drill is worshipped at the time of sowing. Not only is the corn itself worshipped at harvest time, and coconuts broken over the heap of the grain, but also the baskets in which the ears are gathered. The bullocks and drivers bringing in the harvest in the Deccan are worshipped by lighted lamps being waved before them. A further stage towards the development of the idea of a deity is seen in the worship of a consecrated stone besmeared with red powder, which may be taken to represent the blood of a victim, by the side of a field.

Similarly, in the Thana District (Bombay), in choosing the deities of a newly founded village, one of them, Cheda, is represented by a long piece of wood or stone besmeared with red powder. This deity may be established without the aid of a Brahman, and is, therefore, still at a very primitive stage of religious thought. In some parts the people believe that a deity resides in every farm or collection of fields, and that good or bad harvests result in his pleasure or displeasure. The genesis of the animal god can be seen in the figure of a tiger made of canes, which is posted in a conspicuous place in the fields of sugar cane. One of the party personates the tiger and is driven off with pieces of cane. At Malad (Thana District) the tiger god Waghoba is worshipped on the 'Tiger Twelfth'—the twelfth day of the month Ashvin (September–October) for the protection of cattle.

Out of these beliefs have grown the cults of the godlings (Bhuta-Devatas) who are the field guardians. In some cases the field guardians are also the Brahmanic godlings, Maruti and Shiva, to whom field-coconuts and flowers are offered. To the others the peasants offer coconuts and sometimes goats or sheep. The propitiation of these spirits tends to centre around certain critical points of the agricultural year, ploughing, sowing, transplanting in the case of the rice crop, and harvest, which fall in certain fixed months and on certain days, thus becoming calendrical. Thus in the Katnagiri district on the no-moon day of Jyeshth (May–June), the people assemble in the temple of the village deity and perform a rite in order that they shall have a good crop, that their village may be free from disease, and that their cattle may be protected; and a similar rite is performed on the first day of the bright half of the month of Margashirsh (November–December), when a goat or sheep is sacrificed on the boundary of the village. The goddess Khema is worshipped to obtain good crops and for the protection of the cattle, but on the full-moon day of Margashirsh a special worship takes place and the sacred gondhal dance is performed, while in Kankaoli, also in the Bombay Presidency, the villagers worship the minor deities of the field with offerings on certain days of each month from Kartik (October–November) up to March.

Societies and Academies.

LONDON.

Optical Society, Nov. 8.—**T. Smith**: (1) On systems of plane reflecting surfaces. An algebraic method is evolved of finding the co-ordinates of the image of any point and of the direction of the emergent portion of any given incident ray after reflection at any number of plane reflecting surfaces. Systems of reflectors are classified according to the nature of the self-conjugate region of the field. A method of designing a system having any assigned properties is described. Suitable criteria are given to determine whether with a prismatic system the whole is non-dispersive, and whether total internal reflection takes place at any given surface; also the boundary conditions at each surface are found. The calculations are simple and free from any ambiguity of sign.—(2) Reflecting systems for image inversion. The above method is applied to an inverting prism. Four surfaces involve oblique refraction into the prism whatever the number and order of the reflections. With five surfaces one form is possible with four reflections. All possible arrangements with six reflections at five surfaces are considered, and the application of the method to prisms with a greater number of reflections is illustrated.—**L. C. Martin** and **T. C. Richards**: The relations between field illumination and the optimum visual field for observational instruments. Experiments based on the application of the results of recent studies on *spatial induction* in vision to determine the conditions governing the optimum size of visual field under certain conditions are described. The results have a bearing on recent efforts to enlarge greatly the fields of view of binoculars, indicating that small fields are better under certain conditions.

Linnean Society, Nov. 15.—**H. Hamshaw Thomas**: Further observations on the cuticle structure of Mesozoic Cycadean fronds. The typical members of the genus *Pterophyllum* are widely different in their epidermal structure from the fronds which have often been placed with them as the section Anomozamites. The rare Yorkshire plant *Pterophyllum Nathorsti*, on its cuticle structure, should be regarded as the type of a new genus. There is no justification for the separation of the numerous forms of *Pterophyllum* from the Lunz Beds (Upper Trias) of Austria into a number of species distinguishable by their dimensions. Cuticle structure indicates that the Palæozoic fronds from the Coal Measures of Blanzy and Commentry in France are more closely allied to the Mesozoic genus *Nilssonia*, and cannot be classed as true Pterophyllums.—**A. H. Clark**: On some recent crinoids in the collection of the British Museum.—**C. A. Nilsson-Cantell**: New and interesting species of *Scalpellum* from a telegraph cable near the coast of North Chile. Four species (two of them new) of barnacles of the genus *Scalpellum* obtained at a depth of 343-400 fathoms are described.—**W. M. Tattersall**: *Asellus cavaticus* Schiodte, a blind isopod new to the British fauna, from a well in Hampshire. Though new to the British fauna, it is rather widely distributed in subterranean waters in France, Germany, and possibly Switzerland. It is a typical cavernicolous species without eyes and without any trace of pigment. It must have been isolated in England at least since early Tertiary times, yet has apparently remained unchanged during that long period of isolation, probably as the result of the very uniform conditions obtaining in underground waters.

Royal Meteorological Society, Nov. 21.—**F. J. W. Whipple**: On the association of the diurnal variation of electric potential gradient in fine weather and the distribution of thunderstorms over the globe. It has been suggested by C. T. R. Wilson that the connexion between the upward currents produced by thunderstorms and the downward currents elsewhere is via the Heaviside layer. Storms are least frequent from 2h. to 4h. G.M.T. (when it is afternoon over the Pacific) and most frequent between 14h. and 20h. G.M.T. (afternoon hours for Africa and S. America). Observations of potential gradient in polar regions and at sea, *i.e.* in parts of the world where there is likely to be little systematic variation in the conductivity of the air, indicate that the gradient has its minimum and maximum values within these same hours. The results are consistent with the Wilson hypothesis.—**N. K. Johnson**: Atmospheric oscillations shown by the microbarograph. The microbarograph invented by Sir Napier Shaw and the late Mr. W. H. Dines frequently gives a regular wave-like record representing oscillations of atmospheric pressure with periods ranging from about 6 minutes to an hour, with a marked maximum for a period of about ten minutes. These oscillations originate at the interface of two air currents possessing different densities and motions. The natural period of vertical oscillation of the atmosphere is connected with the lapse rate of temperature, and the most frequent period of oscillation recorded corresponds with the most frequent lapse rate.

EDINBURGH.

Royal Society, Nov. 5.—**J. R. Thompson**: The general expression for boundary conditions and the limits of correlation. The study of correlated variables suggests a complex array of factors, among which it is required to state the highest degree of generality we are compelled to assume and yet retain the possibility of producing a given set of correlations. This purpose is served by the boundary conditions, which can be expressed in general by a determinant of the correlation coefficients and one parameter k, the latter taking the value -1, -2, -3, etc., respectively according as the 1st, 2nd, 3rd, etc., boundary condition is required. When $k = +1$ the determinant gives a condition stated by J. C. Maxwell Garnett (*Proc. Roy. Soc.*, 1919) as indicating the presence of two general factors in three variables and three general factors in four variables. Agreement between these results and the boundary conditions is established by a definition of Maxwell Garnett's general factor in terms of ultimate elements.—**John Mackie**: Mathematical consequences of certain theories of mental ability. On the supposition that four mental abilities are due to N variable factors, and that the proportions in which they act are determined by chance, the probable value of the tetrad-difference F is calculated. Following the geometrical treatment employed by Maxwell Garnett, we find that if N is large, σ_F is approximately inversely proportional to $\sqrt{N}$, so that by supposing N to be large we get σ_F to be small. The various abilities are represented by directed lines in N-dimensional space, and by considering all possible lines and taking any four at random, we obtain as a probable result $F = O \pm$ a small quantity.—**T. P. Black**: Mental measurement: The probable error of some boundary conditions in diagnosing the presence of group and general factors. J. Ridley Thompson, by examining correlation coefficients, has developed criteria for testing whether in mental activities 'general' or 'group' factors are necessarily present. In the case of three variables and $K = -1$ the probable error of his function reduces to

$$\frac{2{\cdot}698}{\sqrt{N}}\sqrt{(1-P_{12}{}^3)(1-P_{23}{}^2)(1-P_{31}{}^2)}.$$

In the development of the mean squared deviation,

terms of order $1/N^2$ have been neglected and normal distribution of the variables has been assumed throughout. —W. F. P. M'Lintock and J. Phemister: A gravitational survey over the buried Kelvin Valley at Drumry, near Glasgow. This survey, with the Eötvös torsion balance, was undertaken by H.M. Geological Survey to amplify what was previously known from a series of isolated borings. The average specific gravity of the sands and clays filling the valley is 1·72, and that of the underlying rocks (Carboniferous Limestone Series), 2·3. The pre-glacial valley of the Kelvin, filled in places to a depth of 300 feet with sand and clay, can be traced from Kirkintilloch to Drumry, where it was supposed to fork against a rock-mass which there rises to 74 feet from the surface, one branch continuing westwards to the north of that mass as a deep channel. The gradients have been determined at 68 stations and an isogam map has been constructed from these gradients.—L. N. G. Filon: On a quadrature formula for trigonometrical integrals. Formulæ of numerical integration such as Simpson's Rule are not applicable as they stand to cases where the integrand is a function which has rapid oscillations, like $f(x)\sin kx$. A formula is derived appropriate for this contingency; it is a generalisation of Simpson's Rule, and reduces to it when k is zero.

PARIS.

Academy of Sciences, Oct. 15.—H. Andoyer: The analytical theory of perturbations and the theorem of Poisson.—Maurice Hamy: A property of diffraction by a circular opening.—Ch. Fabry: The rôle of the atmospheres in the occultations of the stars by the planets. A discussion of the probable effects of atmospheres on the planets on the phenomena observed during the occultation of a star.—Ch. Nicolle, C. Mathis, and Ch. Anderson: The unicity of the recurrent spirochætes of the Dutton group.—Georges Giraud: Non-linear partial differential equations of the second order of the elliptic type.—Florin Vasilesco: The surfaces of level of the potential of an aggregate of points.—N. Cetajev: The Poisson stability.—F. Rochefort: A new method of feeding explosion motors. A special form of pulveriser is described capable of utilising gas oil as fuel, for which the flexibility of the petrol carburettor is claimed.—J. Peltier: The equations of motion of a motor-car.—R. Mazet: Flow through a long, narrow rectangular orifice.—D. Eginitis: The problem of the tide of Euripus.—R. Jarry-Desloges: Researches on the position of the axis of rotation of the planet Venus.—Paul Lévy: The vibrating spaces of M. Winter.—W. Broniewski and B. Hackiewicz: The structure of the copper-tin alloys. In this work an attempt to reach true equilibria in the alloys was made by means of prolonged annealing, in one case for 7000 hours at 299° C. The slowness with which equilibrium is established, as established by this work, proves the preponderating importance of annealing in the study of the structure of alloys by indirect methods.—Jean Cabannes: The depolarisation of the secondary radiations in the complex light which results from the molecular diffusion of a monochromatic radiation.—J. Harroy and A. Brichant: The discovery of a coal basin in eastern Morocco.—Marcel E. Denaeyer: Geological sketch of French equatorial Africa, of the Cameroons, and neighbouring regions.—L. W. Collet, R. Perret, M. Billings, and Mlle. R. A. Doggett: The presence of the crystalline of the Aiguilles Rouges massif in the Cirque du Fer à Cheval (Hautes Alpes limestones of Sixt, Haute Savoie).—Ch. Courtot: The condensation of chloroindane with phenols.—Bourguel and Rambaud: The catalytic influence of the hydrogen ions in the internal dehydration of a cis-ethylenic γ-glycol in the presence of water.—R. Combes: Critical study of the method of Sachs applied to the measurement of migrations of substances. The author considers that the errors inherent in Sachs's method render it useless for the study of the migration of substances in leaves.—L. Maume and J. Dulac: The positive, zero, and negative antagonism of binary mixtures of electrolytes with regard to plants.—André Piédallu and A. Balachowsky: The utilisation of chloropicrin against cochineal insects harmful to orange trees or date palms. Chloropicrin is effective for this purpose if used in doses of 15-20 gm. per cubic metre.—R. Guillin: The integral dissociation of silicates by carbonic acid, by humic acids, and connected reactions. Whatever may be the nature of the humus-bearing soils, and whether containing lime or not, carbonic acid and the humic acids can cause the disintegration of silicate rocks, sodium and potassium being first eliminated, then lime and magnesia, and finally the aluminium, the latter alone remaining fixed to the humic acids.—Philippe Fabre: The inefficacity of prolonged continuous currents in neuro-muscular stimulation.—René Hazard and Mlle. Jeanne Lévy: The cardiovascular action of the semicarbazone of tropinone and of the oximes of tropinone and pseudopelletierine.—A. Paillot: Experimental amicrobial silk-worm disease (*gattine*) and the rôle of intestinal cytotoxic substances in the epidemiology of silk-worm diseases.—Moycho: The action of bacterial proteolytic enzymes: the influence of *p*H on proteolysis. In acid media, *p*H 4, the proteolytic enzyme of *B. pyocyaneus* does not act on gelatine, whilst the enzyme of *B. prodigiosus* acts with difficulty. As the acidity is reduced the proteolytic action increases, reaching a maximum at about *p*H 8, after which it diminishes.—R. Douris and J. Beck: A simple reaction for differentiating normal and syphilitic sera with the aid of organic colloids. The proposed reagent is a solution of sodium oleate acidified in the presence of the serum with dilute phosphoric acid. Advantages are claimed for this sero-diagnostic method over those in ordinary use for the detection of syphilis.—Y. Manouélian and J. Viala: The nerve cells and the virulence of the pneumogastric in canine hydrophobia.—Bordier: A new application of high frequency currents: medicinal d'Arsonvalisation.

Oct. 22.—G. Bigourdan: Description of a new form of comet finder.—Ch. Fabry: The rôle of the atmospheres in occultations of stars by the planets. Assuming the existence of atmospheres on the planets, details are given of the effects on the occultation of stars which might be expected. The cases of Mars, Mercury, Venus, Jupiter, Saturn, and the moon are considered.—Maurice de Broglie: Remark on the fine structure of the Compton effect. —Jean Perrin and Mlle. Choucroun: The velocity of photochemical reactions. A photochemical study of two chemical reactions where the reagents were practically non-fluorescent. The law of mass action was found to apply to each of these.—J. Auclair and J. Villey: The thermodynamic diagram of the Rochefort system.—Delloue: Lines of curvature passing through an umbilicus.—Laurence Chisholm Young: The change of variable in simple absolutely convergent integrals.—Fr. Wolf: Theorems of unicity of trigonometrical series representing pseudo-periodic functions.—Grialou: Rotational movement of non-perfect liquids with permanent regime.—Mokrzycki: The determination of the characteristics of an aeroplane based on the petrol consumption.—N. Stoyko: The influence of the personal equations on the determination of the time by the meridian telescope, with an impersonal micro-

meter.—**L. Goldstein**: The passages caused in wave mechanics.—**Néda Marinesco**: Dielectric properties and the structure of absorbent colloids. From measurements of the dielectric constants of solutions of varying concentrations of methæmoglobine, soluble starch, and gum arabic, a figure is calculated giving the number of cubic centimetres of water dielectrically saturated and fixed per gram of solid colloid.—**R. de Mallemann**: The internal field of polarisation. A new theoretical expression for the refractive power is calculated. The Lorentz factor $(K+2)/3$, or Gladstone factor $(\sqrt{K}+1)/2$ is replaced by $3K/(2K+1)$.—**Paul Soleillet**: The polarisation of the resonance radiations of zinc. From the experimental results given, the approximate value of the mean life of the atom in the excited state is calculated on the basis of Elridge's theory; it is $T=10^{-5}$.—**A. Nodon** and **G. Cuvier**: Researches on the radioactivity of wines. The radioactivity found in the specimens examined varied between 0·1 and 0·01 that of uranium.—**J. Errera**: Molecular associations. Relations between the vapour pressure of binary liquid mixtures and the polarity of the molecules of the constituents.—**R. Levaillant**: The preparation of neutral sulphuric esters. Details of the method of preparation of *n*-propyl chlorsulphonate and *n*-propyl sulphate and of the corresponding β-chlorethyl compounds.—**N. Menchikoff**: The age of the Ougarta grits (Western Sahara).—**A. Rivière**: The prolongation into Italy of the Pyrenees-Provençal irregularities of the east of the Maritime Alps.—**Auguste Lumière** and **Mme. Malespine**: Protection against anaphylactoid shock by means of magnesium hyposulphite. The shock produced by the injection of barium sulphate suspensions can be minimised by the simultaneous injection of a solution of magnesium hyposulphite.—**A. Policard**: The variations of thermal retraction shown by various regions of the ossification cartilage.

GENEVA.

Society of Physics and Natural History, Oct. 25.—**G. Tiercy**: The method of indicating gaining or losing of chronometers. A recent discussion compares the method used by seamen, in which the *correction* is given with its algebraic sign, with that of the clockmakers, who give the *rate*, that is to say, the quantity by which the chronometer gains or loses: these two magnitudes are connected by the relation: Correction = −(rate). He decides in favour of the clockmakers' view, which he considers more in accordance with the interpretation of the plain meaning of the words gain or loss.—**R. Matthey**: The chromosomes of the viper (*Vipera aspis*). The diploid number $2N$ is 41. There are 21 macrochromosomes and 20 microchromosomes. The haploid plates of the first kinesis amount to 11 large elements and 10 small; those of the second kinesis have sometimes 11, sometimes 10 macrochromosomes, hence there is male digamety and heterochromosomy of the type $X0$.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, Vol. 14, No. 9, Sept. 15).—**D. L. Webster, H. Clark, R. M. Yeatman**, and **W. W. Hansen**: Intensities of *K*-series X-rays from thin targets. The targets consisted of films of silver deposited by evaporation of molten silver on to a beryllium block; their thickness ranged from about 30 A. to about 280 A. Such films allow almost all the cathode rays to pass without appreciable loss of energy, and give a measure of the relative intensities of *K*-series X-rays. Present theories of the effect are only qualitatively in accord with the results.—**C. J. Brasefield**: The spectrum of the hydrogen molecular ion. A canal ray beam was photographed 0·5 cm. behind the cathode and perpendicularly to the beam, with varying pressures. Photometric records of the plates showed that the lines could be divided into three groups: (1) a large number increased rapidly in intensity with increasing pressure; they are due to excitation of the resting gas by moving hydrogen molecular ions; (2) a group of lines of almost constant intensity; and (3) a third group, which increased in intensity to a maximum at pressures of 0·005-0·008 mm. of mercury, and then decreased; these are due to hydrogen molecular ions (H_2^+). These last have been arranged in branches.—**Louis Harris**: The absorption spectrum of nitrogen dioxide. Pure nitrogen dioxide was examined in quartz cells. Keeping one set of cells at 125°-140° C. gave the spectra of the single molecules, NO_2; reducing the temperature gave spectra of mixtures of single, NO_2, and double molecules, $(NO_2)_2$. At −42° to 28° C., spectra were obtained of the double molecules $(NO_2)_2$, in the gaseous phase alone. The single molecules give many bands, several with fine structure, between 6000 A. and 2250 A.; distinct bands appear in the region 2600-2250 A. Absorption due to double molecules is continuous; two bands with maxima at 3500 A. and farther in the ultra-violet merge into a continuous band extending from 4000 A. into the far ultra-violet at high pressures.—**R. C. Gibbs** and **C. V. Shapiro**: The relation of hydrolysis to the validity of Beer's law. This law, that extinction, for a given thickness, is proportional to the concentration, is based on the assumption that no changes occur in the character of the absorbing centres with varying concentration. Data obtained with phenol phthalein and its derivatives and other indicators in alcoholic solution show that this assumption is not justified owing to the occurrence of hydrolysis, which produces new types of absorption centres. Hence solutions of 'neutral' salts of the phthalein series do not give the true absorption of the ion of the alkali salt.—**Richard C. Tolman**: Further remarks on the second law of thermodynamics in general relativity. An expression for the second law applied to an infinitesimal four-dimensional region in flat space-time is obtained from the older thermodynamics, and, on the basis of the equivalence hypothesis, this is regarded as true in curved space-time. The expression is generalised in co-variant form.—**J. R. Green** and **R. J. Lang**: Series spectra of cadmium-like atoms. The results for Sb IV have been classified.—**Donald A. Johansen**: The hypostase: its presence and function in the ovule of the Onagraceæ. The hypostase is a group of thick-walled cells between the bases of the two integuments of the ovule and directly on top of the end of the vascular bundle entering the latter. From an examination of many species of Onagraceæ from different habitats, it appears that it is an acquired characteristic arising as required to stabilise the water balance of a resting seed which will be dormant during a hot, dry season.—**G. H. Parker**: Glycogen as a means of ciliary reversal. Filter paper, which was rejected by the sea-anemone, *Metridium marginatum*, was carried in towards the mouth when impregnated with glycogen, due apparently to a reversal of the ciliary current.—**H. J. Muller**: The production of mutations by X-rays. An account of the work on the fly *Drosophila* and other organisms, with a bibliography. β-radiation appears to be most effective; the number of mutations varies with the dosage, but the 'degree' or character of the individual mutations does not. Changes other than losses in the chromosomes have been found.—**Morris Marden**: On the roots of a derivative of a polynomial.—**Tracy Yerkes**

Thomas: Concerning the *G group of transformations.—Oswald Veblen: Conformal tensors and connections. The system of invariants appropriate to the conformal geometry of Riemannian spaces.—Aristotle D. Michal: The group manifold of finite continuous point and functional transformation groups.

Official Publications Received.

BRITISH.

Development Commission. Eighteenth Report of the Development Commissioners for the Year ended the 31st March 1928. Pp. 200. (London: H.M. Stationery Office.) 3s. 6d. net.

Proceedings of the Royal Society. Series A, Vol. 121, No. A787. Pp. 477. (London: Harrison and Sons, Ltd.) 16s.

The Journal of the National Institute of Agricultural Botany. Vol. 2, No. 1. Pp. 84. (Cambridge: W. Heffer and Sons, Ltd.) 2s. 6d. net.

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 66, No. 383, November. Pp. 1101-1244+xxxii. (London: E. and F. N. Spon, Ltd.) 10s. 6d.

Transactions of the Royal Geological Society of Cornwall. Vol. 16, Part 1: The One Hundred and Fourteenth Annual Report of the Council, with the Reports of the Treasurer and Curator and Papers read to the Society. Pp. 31. (Penzance.) 4s.

The North of Scotland College of Agriculture. Report on the Work of the North of Scotland College for the Year 1927-28. Pp. 26. (Aberdeen.)

Government of Madras. Administration Report of the Government Museum and the Connemara Public Library for the Year 1927-28. Pp. 16. (Madras: Government Museum.)

Latex. By Dr. Henry P. Stevens. Pp. 68. (London: The Rubber Growers' Association, Inc.)

Report of the International Conference on Cancer, London, 17th-20th July 1928, held under the Auspices of the British Empire Cancer Campaign. Pp. xxi+588. (Bristol: John Wright and Sons, Ltd.; London: Simpkin Marshall, Ltd.)

FOREIGN.

United States Department of Agriculture. Technical Bulletin No. 80: Tests of Blowfly Baits and Repellents during 1926. By D. C. Parman, E. W. Laake and F. C. Bishopp, and R. C. Roark. Pp. 15. (Washington, D.C.: Government Printing Office.) 5 cents.

Department of Commerce: Bureau of Standards. Research Paper 29: Thermal Expansion of Magnesium and some of its Alloys. By Peter Hidnert and W. T. Sweeney. Pp. 771-792+2 plates. (Washington, D.C.: Government Printing Office.) 10 cents.

Department of the Interior: Bureau of Education. Bulletin, 1928, No. 8: Schools for the Deaf, 1926-27. Pp. 17. (Washington, D.C.: Government Printing Office.) 5 cents.

Proceedings of the United States National Museum. Vol. 73, Art. 22: Tertiary Fossil Plants from the Argentine Republic. By Edward W. Berry. (No. 2743.) Pp. 27+5 plates. (Washington, D.C.: Government Printing Office.)

Bergens Jæger- og Fiskerforening. Rypeundersøkelsen 1921-1927. Pp. 18+18+21+9+4+20+41+8+8+54+13+34+8+5+8+9+71+5+8+67+16+52+38+49+35+84+118. (Bergen: A/S John Greigs Boktrykkeri.)

The Museum of the Brooklyn Institute of Arts and Sciences. Science Bulletin, Vol. 3, No. 5: Heterocephalus, the remarkable African Burrowing Rodent. By W. J. Hamilton, Jr. Pp. 173-184+3 plates. (Brooklyn, N.Y.)

Department of the Interior: U.S. Geological Survey. Bulletin 775: Geology and Lignite Resources of the Marmarth Field, Southwestern North Dakota. By C. J. Hares. Pp. vi+110+14 plates. 35 cents. Bulletin 798: Geology of the Muddy Mountains, Nevada; with a Section through the Virgin Range to the Grand Wash Cliffs, Arizona. By Chester R. Longwell. Pp. vi+152+17 plates. 50 cents. Bulletin 802: Bibliography of North American Geology for 1925 and 1926. By John M. Nickles. Pp. iii+286. 40 cents. Professional Paper 153: Studies of Basin-Range Structure. By Grove Karl Gilbert. Pp. vii+92+40 plates. 60 cents. Water-Supply Paper 540: Ground Water in the New Haven Area, Connecticut. By John S. Brown. Pp. vi+206+15 plates. 60 cents. Water-Supply Paper 581: Surface Water Supply of the United States, 1924. Part 1: North Atlantic Slope Drainage Basins. Pp. vi+246. 25 cents. Water-Supply Paper 590: Surface Water Supply of the United States, 1924. Part 10: The Great Basin. Pp. v+131. 20 cents. (Washington, D.C.: Government Printing Office.)

Diary of Societies.

FRIDAY, DECEMBER 7.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 10.30 A.M.—G. F. Jenkins, T. B. Layton, E. D. Davis, and others: Discussion on Meningitis.

INSTITUTION OF WATER ENGINEERS (at Geological Society), at 10.30 A.M.—J. Bowman: The Consumption and Waste of Water.—E. J. Rimmer: Legal Considerations relating to the Administration of Engineering Contracts.—A. W. Burtt: The Sandfields.—W. T. Halcrow, G. B. Brook, and R. Preston: The Corrosive Attack of Moorland Water on Concrete.

ROYAL ASTRONOMICAL SOCIETY, at 4.30.—Geophysical Discussion on Atmospheric Ionisation. Chairman, Dr. G. C. Simpson. Discussion to be opened by Prof. J. Nolan, and continued by Dr. J. S. Owens, Prof. A. M. Tyndall, and R. E. Watson.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 5.

INSTITUTION OF ENGINEERING INSPECTION (at Royal Society of Arts), at 5.30.—C. H. Faris: The Application of Electro-deposited Metals to Engineering.

PHILOLOGICAL SOCIETY (at University College), at 5.30.—Prof. F. W. Thomas: Weak R in Central Asia.

BRITISH PSYCHOLOGICAL SOCIETY (Æsthetics Section) (at Bedford College for Women), at 5.30.—J. Littlejohns: The Appreciation of Pictures.

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (at Liverpool University), at 6.—Prof. H. E. Armstrong: Hurter Memorial Lecture.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Mining Institute, Newcastle-upon-Tyne), at 6.30.—K. O. Keller: Combustion and its Difficulties in Marine Oil Engines.

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (jointly with Institution of the Rubber Industry—Manchester Section) (at Geographical Hall, Manchester), at 7.—Dr. L. Auer: Colloid-Chemical Changes in Rubber and in Fatty Oils.

INSTITUTION OF ELECTRICAL ENGINEERS (Meter and Instrument Section), at 7.—W. Holmes: Load Levelling Relays and their Application in Connexion with Future Metering Problems.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—F. E. Robinson: Works Committees.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group—Informal Meeting), at 7.—H. Bairstow: Bromoil Transfer.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—Lt.-Col. J. T. C. Moore-Brabazon: The Future of Coal in relation to Industry (Presidential Address).

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—J. G. C. Leech: St. Austell Detritals.—H. G. Smith: Some Features of Cornish Lamprophyres.

TEXTILE INSTITUTE (Lancashire Section) (jointly with Bolton and District Managers', Carders', and Overlookers' Association) (at Saddle Hotel, Bradshawgate, Bolton), at 8.—A. Roe: Cleaning of Cotton in the Blowing Room.

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30.—S. Rowbotham: Preliminary Medication in Anæsthetics.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at Thomas' Café, Swansea).—Prof. T. C. James: Pollution of Rivers.

OXFORD UNIVERSITY JUNIOR SCIENTIFIC CLUB.—Sir E. Farquhar Buzzard: The Harvey Tercentenary Film.

SATURDAY, DECEMBER 8.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—W. Bayes: The Gulf between Painter and Public (I.).

MINING INSTITUTE OF SCOTLAND (at Royal Technical College, Glasgow), at 3.—J. S. Frame: Pavement Brushing versus Roof Brushing.—*Papers to be discussed:*—An Experience of Machine Mining in a Highly Inclined Seam, J. M. Williamson and J. Bilsland; Some Impressions of German Mining, D. C. Gemmell and J. Heron; Tru-lay Wire Ropes and Tru-lock Fittings, A. T. Adam.

MONDAY, DECEMBER 10.

CAMBRIDGE PHILOSOPHICAL SOCIETY (in Cavendish Laboratory), at 4.30.—Dr. H. Jeffreys: On the Transverse Circulation in Streams.—J. Hargreaves: The Dispersion Electrons of Lithium.—W. R. Harper: The Obliquity Function to be Used in the Approximate Theory of Diffraction.—C. E. Eddy: The Passage of β-rays through Matter.—*Papers to be communicated by title only:*—H. D. Ursell: (*a*) Cayley's Problem of Seven Lines on a Quartic Surface; (*b*) Coincidence Formulæ in Geometry.—J. A. Todd: On the Number of Planes in Hyperspace which Satisfy a Certain Set of Conditions.—W. N. Bailey: Note on Bateman's Expansion in Bessel Functions.—H. Pfeiffer: Der Isoelektrische Punkt von Zellen und Geweben.—P. Tate: The Dermatophytes, or Ringworm Fungi.—W. Seifrig: The Structure of Protoplasm.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—S. W. Boggs, A. R. Hinks, and others: New Map Projections.

ROYAL SOCIETY OF MEDICINE (War Section), at 5.—Surg.-Comdr. P. M. Rivaz: Some Common Problems in Naval Hygiene.

INSTITUTION OF AUTOMOBILE ENGINEERS (Birmingham Centre) (at Queen's Hotel, Birmingham), at 7.—Major C. G. Nevatt: Experiments on Self-Energised Brakes.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—E. W. Dorey and others: Discussion on Power Factor Tariffs and Methods of Metering.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (in Laboratories of Applied Electricity, Liverpool University), at 7.—E. H. Shaughnessy: Transatlantic Radio Telephony.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—E. B. Wedmore, W. B. Whitney, and C. E. R. Bruce: An Introduction to Researches in Circuit Breaking.

INSTITUTION OF AUTOMOBILE ENGINEERS (jointly with Institution of the Rubber Industry) (at Blackfriars Theatre, William Street, E.C.4), at 7.30.—W. H. Paull: The Tyre as an Article of Manufacture and Usage.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (Associate Members' and Graduates' Branch) (at Borough Polytechnic), at 7.30.—E. T. Ollett: Air Filtration.

INSTITUTE OF METALS (Scottish Local Section) (at 39 Elmbank Crescent, Glasgow), at 7.30.—F. Hudson: Scottish Moulding Sands and their Application to Non-Ferrous Casting.

SURVEYORS' INSTITUTION, at 8.—F. G. Fleury: The Recent Rating Acts in Operation.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College).—Miss M. B. Stott: An Experiment in Vocational Guidance.

INSTITUTION OF ELECTRICAL ENGINEERS (Western Centre) (at South Wales Institute of Engineers, Cardiff).—W. W. Woodhouse: Overhead Electric Lines.

TUESDAY, DECEMBER 11.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Sir William Bragg: Diamonds (IV.).

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—Dr. A. Wade: Madagascar and its Oil Lands.

ILLUMINATING ENGINEERING SOCIETY (at 15 Savoy Street), at 6.30.—H. Lingard: The Use of Electric Lighting for Advertising Purposes.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—A. Greenfield: Practical Refrigeration for Ships.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—W. W. E. French: Short-Circuits in Large Power Systems.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7.—L. Romero and others: Discussion on Tariffs.

INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (at North British Station Hotel, Edinburgh), at 7.—F. Lydall: The Electrification of the Pietermaritzburg-Glencoe System of the South African Railways.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—A. Coleman: From Suez to the Himalaya.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Centre) (at Broadgate Café, Coventry), at 7.30.—Major C. G. Nevatt: Experiments on Self-Energised Brakes.

PHARMACEUTICAL SOCIETY, at 8.—Dr. Katharine H. Coward: Recent Research on the Vitamins.

BRITISH INSTITUTE OF PHILOSOPHICAL STUDIES (at Royal Society of Arts), at 8.15.—S. K. Ratcliffe: The Impact of America on Western Civilisation (Lecture).

WEDNESDAY, DECEMBER 12.

ROYAL SOCIETY OF MEDICINE (History of Medicine Section), at 5.—Prof. Franchini: Malpighi.

INSTITUTION OF CIVIL ENGINEERS (Informal Meeting), at 6.—J. Whitehouse and others: Discussion on Methods of Reducing Temperature in Deep Mining Work.

INSTITUTE OF CHEMISTRY (Edinburgh and East of Scotland Section) (jointly with Institution of the Rubber Industry) (at 36 York Place, Edinburgh), at 7.30.—R. Wheatley: Methods of Heating in the Rubber Industry.

SOCIETY OF CHEMICAL INDUSTRY (Newcastle-upon-Tyne Section) (at Armstrong College, Newcastle-upon-Tyne), at 7.30.—B. Thomas and F. J. Elliott: The Changes in Soil Reaction Effected by Long Continued Manuring.

ROYAL SOCIETY OF ARTS, at 8.—G. G. Blake: Applications of Electricity to Medical Practice.

ELECTROPLATERS' AND DEPOSITORS' TECHNICAL SOCIETY (at Northampton Polytechnic Institute), at 8.15.—U. R. Evans: The Corrosion of Metals, with Special Reference to Protective Metallic Coverings.

EUGENICS SOCIETY (at Royal Society), at 8.30.—Dr. M. Ginsberg: Interchange between Social Classes.

SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (jointly with Royal Philosophical Society, Glasgow).—Dr. T. Gray: Low Temperature Carbonisation of Coal.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at Engineers' Institute, Cardiff).—Dr. S. Wolff and others: Discussion on The Scope of a Chemical Engineer, with Special Reference to Boiler-house Practice.

THURSDAY, DECEMBER 13.

LINNEAN SOCIETY OF LONDON, at 5.—Dr. A. W. Hill: A Botanist's Official Tour in Australia and New Zealand.—Dr. S. L. Hora: Evolution: Divergent and Convergent.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—W. N. Bailey: Asymptotic Expansions of Products of Bessel Functions.—T. W. Chaundy: A Diophantine Trifle.—P. J. Daniell: Stieltjes Derivatives.—W. L. Ferrar: On Sequences of Analytic Functions.—Prof. L. J. Mordell: Poisson's Summation Formula and the Riemann Zeta Function.—E. G. Phillips: Note on Summation of Series.—E. G. C. Poole: Dirichlet's Principle for a Flat Ring (Second Paper).—Katherine I. Sayers: Cesàro Summation of Stieltjes-Fourier Series and their Conjugates.—W. M. Shepherd: Note on Generalised Plane Stress.—Mary Taylor: On the Existence and the Uniqueness of the Solution of Cauchy's Problem for a System of Two First Order Partial Differential Equations.—Prof. E. T. Whittaker: On the Recurrence Formula for the Mathieu Functions.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Sir Richard Paget, Bart.: Human Speech: a Musical Phenomenon: Some Conclusions (II.).

SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (at Chamber of Commerce, Birmingham), at 7.—Dr. L. H. Lampitt: Developments of Dried Milk Industry, with Special Reference to Spray Drying.

INSTITUTE OF METALS (Birmingham Local Section) (at Engineers' Club, Birmingham), at 7.—E. Player: Magnesium Alloys for Engineering.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Colour Group—Informal Meeting), at 7.—F. J. Tritton and others: Discussion on The Three-Colour Carbro Process.

INSTITUTION OF CIVIL ENGINEERS (Yorkshire Association) (at Hotel Metropole, Leeds), at 7.30.—A. H. D. Markwick: Power Station Construction.

INSTITUTION OF ELECTRICAL ENGINEERS (Dundee Sub-Centre) (at University College, Dundee), at 7.30.—H. K. Hunter: Radio Receivers: Design, Practice, and Tendencies in 1928–29.

INSTITUTE OF METALS (London Local Section) (jointly with Institute of British Foundrymen) (at 83 Pall Mall), at 7.30.—R. B. Deeley: Aluminium-Silicon Alloys; their Properties and some Applications.

OPTICAL SOCIETY (at Imperial College of Science), at 7.30.—B. E. Mourashkinsky and Miss M. Savostianoff: The Measurement of Axial Aberrations of Telescopic Systems of Small Magnification.—T. Smith: Note on Skew Pencils traversing a Symmetrical Instrument.

INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre—Dublin) (at Trinity College, Dublin), at 7.45.—P. A. Spalding: Commercial Problems relating to the Application of Electricity from the Shannon Distribution System.

C.B.C. SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Essex Hall, Essex Street), at 8.—Dr. C. W. Saleeby: Cancer Control via Birth Control Clinics.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Chandos Street, W.), at 8.15.—Dr. A. K. Gordon: The Rôle of the Spleen in the Causation of Hæmorrhage.

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY, at 8.30.—G. E. Bell: Constant Voltage High Tension Generators.—Dr. J. D. White: Abnormalities of the Bony Thorax.

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Dr. Parkes Weber: Note on the Association of Extensive Hæmangiomatous Nævus of Skin, with Cerebral (especially Meningeal) Hæmangiomata.—Dr. J. G. Greenfield: Measles Encephalitis.—Dr. R. M. Stewart: The Pseudo-polyneuritic Type of Amyotrophic Lateral Sclerosis.

INSTITUTION OF MECHANICAL ENGINEERS (Cardiff Branch).—Dr. H. W. Swift: Power Transmission by Belts: an Investigation of Fundamentals.

FRIDAY, DECEMBER 14.

ROYAL ASTRONOMICAL SOCIETY, at 5.—G. Shajn and O. Struve: On the Rotation of the Stars.—Prof. E. A. Milne: Ionisation in Stellar Atmospheres: Part II. Absolute Magnitude Effects.—H. Zanstra: The Excitation of Line and Band Spectra in Comets by Sunlight.—M. Minnaert: The Distribution of Energy near the Limb of the Sun.—C. Easton: A Photographic Chart of the Northern Milky Way.—J. Evershed: High Dispersion Prism Spectra.

BIOCHEMICAL SOCIETY (in Laboratories of J. Lyons and Co., Ltd., Hammersmith Road), at 5.—Prof. J. C. Drummond and L. C. Baker: Further Chemical Studies of the Vitamin A Fraction of Liver Oils.—B. Russell-Wells and Dr. P. Haas: The Hydrolysis of Carragheen Mucilage.—C. R. Harington: The Resolution of d, l-thyroxine.—M. W. Goldblatt: The Action of Insulin in Young Rabbits.—E. Clenshaw and I. Smedley Maclean: The Nature of the Unsaponifiable Matter from the Lipoids of Spinach and Cabbage Leaves.—L. H. Lampitt and P. Bilham: The Effect of Some Constituents of Milk on its Hydrogen Ion Concentration.—D. H. F. Clayson: The Diastatic Digestion of Raw Wheat Starch.—L. H. Lampitt and J. B. Bushill: Some Observations on the Determination of Surface Tension by the Ring Method, with Special Reference to Egg Albumin.—E. B. Hughes: Some Observations on the Production of Liesegang Rings.

IMPERIAL COLLEGE CHEMICAL SOCIETY, at 5.—H. L. Riley and others: Informal Discussion on The Problem of Molecular Structure.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section) (Clinical Meeting) (at Royal Westminster Ophthalmic Hospital), at 5.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—Dr. Ezer Griffiths: A Survey of Heat Conduction Problems (Lecture).

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—E. G. Herbert: Machinability.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 6.15.—T. H. Lockett: The Applications of Electricity in the Printing Industry.

JUNIOR INSTITUTION OF ENGINEERS, at 7.—E. J. H. South: Locomotive Boiler Washing Plant.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE (at Royal Technical College, Glasgow), at 7.—Prof. W. A. Scott: Commercial Paper.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at College of Technology, Manchester), at 7.—Lt. B. Atkinson: How Electricity does Things (Faraday Lecture).

INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch, Burnley Section) (at Municipal College, Burnley), at 7.15.—S. Stanworth: Comparison of English and French Moulding.

INSTITUTE OF METALS (Sheffield Local Section) (in Department of Applied Science, Sheffield University), at 7.30.—L. Wright: Chromium Plating.

OIL AND COLOUR CHEMISTS' ASSOCIATION (Manchester Section) (at Milton Hall, Manchester), at 7.30.—R. A. Bellwood: Present Day Methods of Oil Extraction.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Dr. C. A. Robinson: The Treatment of Pelvic Inflammation by Diathermy.

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group).—N. Swindin: The Air and Gas Lift as a Chemical Appliance.

SOCIETY OF DYERS AND COLOURISTS (Manchester Section).—Prof. F. M. Rowe and Dr. C. P. Bean: The Effect of After-treatments on the Degree of Aggregation and Fastness Properties of Insoluble Azo Colours on the Fibre.

SATURDAY, DECEMBER 15.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Newcastle-upon-Tyne), at 2.30.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—W. Bayes: The Gulf between Painter and Public (II.).

INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch, Junior Section) (at College of Technology, Manchester), at 7.—G. Mohn: The Application of the Microscope to the Study of Metals and Alloys.

PUBLIC LECTURES.

FRIDAY, DECEMBER 7.

KING'S COLLEGE, at 5.30.—Sidney Smith: Babylonian Amulets.

SATURDAY, DECEMBER 8.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—R. Aitken: Life and Traditions in the Spanish Rioja.

TUESDAY, DECEMBER 11.

EAST ANGLIAN INSTITUTE OF AGRICULTURE (Chelmsford), at 7.—Prof. G. Scott Robertson: The Use of Minerals in the Feeding of Poultry.

WEDNESDAY, DECEMBER 12.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Prof. E. W. Hope: Industrial Diseases as viewed from the Standpoint of a Medical Officer of Health.

UNIVERSITY COLLEGE, at 5.30.—Dr. R. Offor: University Library Buildings.

CONFERENCE ON DRYING.

THURSDAY AND FRIDAY, DECEMBER 6 AND 7.

INSTITUTION OF CHEMICAL ENGINEERS (at Chemical Society).

Friday, Dec. 7, at 10.30.—T. J. Horgan: Rotary Dryers.—G. W. Riley: Vacuum Drying.

At 2.30.—Dr. S. G. Barker: The Hygroscopic Nature of Textile Fibres.—B. J. Owen: The Drying of Agricultural Products.—A. C. Barnes: Some Drying Problems in Tropical Africa.