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Problems in Human Nutrition.

IN the acquirement of knowledge by the experimental method, with the attention to minute detail which accurate and successful work demands, it is sometimes useful to pause a while and raise the eyes from the task in hand, and to take a general survey of the field—what has already been accomplished and what still remains to be done. Some reflections on problems in nutrition are suggested by perusal of the thirteenth annual report of the Medical Research Council, more especially as one chapter of our knowledge of the elusive, but extremely important, accessory food factors appears closed, even though the next may be already partly written. The discovery that ergosterol is the precursor of vitamin D, and is converted into it on irradiation by ultra-violet light or by exposure to sunlight, has already been referred to in these columns (NATURE, vol. 120, p. 955 ; 1927) : it is now possible for the first time to produce a vitamin from a pure chemical compound in the laboratory or even in the factory, so that an ample supply should be readily available for all.

Advances made, however, in one branch of nutritional studies, striking though they are, should not lead us to forget the importance of the other elements of the diet, the salts, the proteins, fats, and carbohydrates, or even the water. All constituents of the diet are worthy of study : scientific knowledge of them is of especial importance to a country which imports the major portion of its food supply. Thus it is known that proteins differ in their 'biological value' ; that is, animals can maintain nitrogenous equilibrium on smaller quantities of some proteins, usually of animal origin, than of others which are usually derived from vegetable sources. What is both the most suitable and also the most economical source or sources of protein for human dietaries ? Again, it is possible for human beings to live on much smaller quantities of protein than are usually consumed, but it is doubtful if this minimum is also the optimum. Another problem of extreme importance is the relationship which the different constituents of the diet should have to one another. Thus the quantity of vitamin B must bear a certain ratio to the amount of protein present : and vitamin A can only exert its full effect on growth in the presence of vitamin D.

The practical application of some of our recently acquired knowledge is mentioned in the Medical Research Council's report and has also been

referred to in NATURE (vol. 120, p. 440; 1927) by O. Rosenheim and T. A. Webster. The supply of milk fat is inadequate for the minimal needs of our population, partly owing to the greater cost of animal fats as compared with vegetable. The chief sources of vitamins A and D have so far been animal fats: in this respect vegetable fat products cannot replace animal. Heretofore, the richest known supplement has been cod-liver oil, but its unpleasant flavour has made it more of a medicine than a dietary supplement to most people. Vitamin D can now be supplied by irradiation of ergosterol, and vitamin A has been found to be present in large amounts in the livers of herbivorous animals, from which it can be easily extracted together with the fat. The supply of liver, fresh or frozen, should be sufficient to meet the requirements of our population for vitamin A; and the fat has the advantage that it is without the unpleasant flavour of the fish oils, so that it can be easily added to vegetable fats or other articles of the diet.

A knowledge of correct nutrition has also a direct bearing on certain medical problems and the prevention of disease. It is only necessary to mention that inadequate intake, relative or absolute, of the appropriate vitamins, is the ultimate cause of scurvy, rickets, beriberi, and pellagra, and probably plays an important part in the initiation of dental decay. It is impossible to say what light future advances in nutritional problems may throw upon certain aspects of preventive medicine.

Much of our knowledge on this subject has been derived from animal experiments: the conclusions drawn can frequently be applied directly to mankind. But it must not be forgotten that results so obtained have another aspect and may throw light on problems facing those who have to breed and maintain animal stock. In the case of the domestic animals, the problem comes back to human nutrition again, in the fattening of stock or in the production of milk of high nutritive value.

Many questions, both of general scientific and practical interest, still await investigation and solution. The nature of the change that occurs in ergosterol under the influence of light, leading to the formation of vitamin D, the further change resulting in the destruction of the vitamin when the irradiation is long continued, and the wave-lengths which are the most active in producing these effects, are still undecided. The solution of these questions has a practical bearing on the optimum conditions for effecting the transformation. Of more academic interest, perhaps, are such problems as the source of the vitamin D which is found in the liver of the cod, or the reason for the absence of this vitamin from mammalian liver. Leigh Clare has shown that the diatom *Nitzschia closterium* contains none of it, so that presumably the cod obtains it from the plankton and smaller fish it consumes, since it is unlikely to be exposed to enough light to synthesise it for itself (*Biochem. Jour.*, vol. 21, p 368; 1927). Again, the body fat of fish is usually free from vitamin A, though it contains vitamin D, but the body oil of eels is rich in both these vitamins; thus does scientific investigation confirm man's empirical selection of certain of his articles of diet. The prospects of the improvement in human well-being which may be expected to result from better knowledge of the influence of diet in the prevention of disease or ill-health make research work on nutrition and its application of prime importance and worthy of generous support from the State and the public.

Czechoslovakian Cytology.

Structure and Development of the "Living Matter." By Prof. F. Vejdovský. (Published with the Assistance of the Ministry of Education of the Czechoslovak Republic.) Pp. vii + 360 + 24 plates. (Prague: Royal Bohemian Society of Sciences; Fr. Řivnáč; London: James Smith, 1926–7.) 147*s*.

THIS volume is one of the largest contributions to cytology published by a single author in recent years. It is written in fairly good English, though in certain more technical parts the translator has not got the equivalent English terminology. Prof. Vejdovský's publications go back at least to 1888, when he brought out his first study on the "Reifung, Befruchtung und Furchung" of the Rynchelmis egg. He is to be congratulated on being at work forty years after.

There are six chapters devoted respectively to the spermatogenesis of the crayfish, the development of the cleavage spindle of Ascaris, and of Rhynchelmis, the structure and development of the somatic cells of Angiospermous plants, the spermatogenesis of the rock kangaroo, and finally a general discussion of the cell constituents. The book contains 360 pages, and the plates are nearly all in colour.

It should be said at once that Prof. Vejdovský's cytology has much in common with that of the celebrated German cytologist F. Meves—perhaps with not so much of the latter's remarkable powers of observation, for Meves, within the limits of his technique, never made a mistake. Prof. Vejdovský

makes many mistakes, and he is a little querulous with those whose views do not coincide with his own. In justice to Prof. Vejdovský, it should, however, be mentioned that the book was meant for publication before the War. As he himself says, he took two years reading up the periodicals he could not get during or just after the War. He has endeavoured to superimpose the results of his reading on his own pre-War cytological views.

The book serves to throw into relief the extensive advances both in microscopical technique and general cytology made by non-continental workers in recent years. Prof. Vejdovský has not kept abreast with modern advances, and in some ways one even feels that he has not learnt what he might have done from the work of Jan Hirschler, F. Meves, and Duesberg, whose publications must have been accessible to him before he went to press.

F. Meves was, in his later years, dominated by the idea that the cytoplasmic inclusions are bearers of the hereditary factors of the cytoplasm. This view is not acceptable nowadays, except in a very moderate form, but Meves's theory never injured his powers of observation. Prof. Vejdovský, on the other hand, allows his theories to lead him into misinterpretations of descriptive cytology.

The book is dominated by two theories—that the acrosome of mammalian spermatogenesis is derived from 'nuclear liquid,' and that the Golgi bodies are a 'mitotic apparatus.' Now there is probably no field in cytology which has been more thoroughly searched than that of the formation of the mammalian sperm from the spermatid. Benda, Niessing, Lenhossék, Hermann, Meves, Moore, Walker, Brown, Duesberg, Papanicolaou, and Stockard, and Woodger and the reviewer, to mention only a few workers, have brought out papers on this subject. In recent years, work by Schütz, Bowen, Voinov, Hyman, and the reviewer has been brought into line with the results of the workers on mammalian spermatogenesis, and confirmed by work in lower vertebrates and invertebrates. Yet Prof. Vejdovský attempts to show that the acrosome is formed as a sort of coagulum from "Karyochyme or nuclear liquid" poured out of the nucleus on to the region of the "mitotic apparatus" (Golgi apparatus). This view is at variance with the careful observations of past and present cytologists. The author has failed to study the spermatocyte and spermatid stages properly, and it is regrettable that he should have devoted so much space to this undoubtedly mistaken interpretation. Perhaps if Prof. Vejdovský had chosen an insect or a mollusc instead of a crayfish for his study of invertebrate spermatogenesis, his views would have changed.

Before the War, and when he was nearly ready to publish his book, Prof. Vejdovský had found the Golgi bodies both in supravitally stained cells and in prepared sections. He was impressed by the fact that in much of his material these bodies hovered near the asters during mitosis. Not being aware of the newer homology of the Golgi apparatus of nerve cells with these bodies, he considered them to be a 'mitotic apparatus.' This quite natural mistake vitiates much that is good in his accounts of mitosis. We cannot definitely claim that the Golgi bodies in these cases do not contribute in some way to the amphiaster, but we do know that the amphiaster can form without Golgi bodies stuck on it, and the idea that the Golgi apparatus is a 'mitotic apparatus' is unacceptable. It seems a pity that Prof. Vejdovský has not familiarised himself with recent work on dictyokinesis, such as that of Ludford, Bowen, Da Fano, *et alia*.

Prof. Vejdovský has observed both mitochondria and Golgi bodies *intra vitam*. There is much in his work of importance to the younger men, and his observations on plant cells should be taken into consideration by those who are now investigating plant tissues so successfully.

The original coloured drawings of Prof. Vejdovský are very beautiful, yet it is interesting to note that the three methods which are most used by modern workers, modified Kopsch, Da Fano, and chrome-osmium hæmatoxylin, all give 'black and white' preparations, and the necessity for coloured plates to illustrate cytological articles is no longer so apparent.

Zoologists who may be interested in cytology are advised to procure Prof. Vejdovský's most interesting publication. J. BRONTË GATENBY.

Acoustics of Buildings.

The Acoustics of Buildings. By Dr. A. H. Davis and Dr. G. W. C. Kaye. Pp. ix + 216 + 22 plates. (London: G. Bell and Sons, Ltd., 1927.) 15*s*. net.

THE high standard of care in preparation and the wealth of illustration which are such notable features of Royal Institution lectures are paralleled in this volume, which is based on the Tyndall lectures of 1926. The account of the lectures already given in NATURE (vol. 99, pp. 603-606) indicates the scope of the book.

The subject is full of fascinating problems, for so much is demanded of a public auditorium. In

many towns the same hall has to be used for speech, chamber music, or a full symphony orchestra and choir. When we realise the minute amount of energy in a human voice, it seems remarkable that a speech in a large hall can be heard at all. R. L. Jones has calculated that if a million persons were to talk steadily, and the energy of their voices were to be converted into heat, they would have to talk for an hour and a half to produce enough heat to make a cup of tea (even if they were all politicians)! The minute amount of energy is, however, compensated for by the remarkable sensitivity of the ear, which can hear a sound of amplitude equal to the wave-length of a penetrating X-ray. Then again the smooth rigid parts of the walls of a hall act as better reflectors of sound than do the best mirrors for light. If, however, these reflecting parts are too far away, the time lag between the direct and reflected ray will cause confusion, and the reflecting power has to be reduced.

The book admirably illustrates that the subject has reached a stage when an architect submitting to experts at, say, our National Physical Laboratory, plans and details of materials for a proposed hall, could be given trustworthy particulars of its acoustics. The principles and necessary details are so clearly set out that he might even make the necessary calculations himself. It should be added that the mere act of consulting experts will not, however, lead to the production of a satisfactory hall if their advice is not followed. This may seem a facetious remark, but it is based upon the reputed facts of a recent famous case when a hall was found, when built, to be quite unsuited for speech, although experts had been consulted.

Whilst prevention is better than cure, the correction of acoustical defects is now so well understood that the acoustics of a faulty hall can always be improved, and in many cases the defects can be entirely removed. One method which will make *no* appreciable difference is in use in our largest auditorium, the Royal Albert Hall in London. Across the ceiling is draped some half-dozen lengths of ordinary wide-mesh wire netting, no doubt a relic of darker ages. This eyesore should be removed out of consideration for the feelings of musical scientists who visit this monument of defective acoustic design.

The use of draping or porous acoustic plaster for rendering hospital wards less reverberant would no doubt be unhygienic. In this and similar cases, such as in typewriting rooms or underground tube railways, the initial generation of sound should be reduced by suitable insulation of the vibrating objects.

The book is admirably produced, and the authors have succeeded in giving all necessary quantitative details in such form that they can be readily understood and applied, even by those with only an elementary knowledge of acoustics. Although there is no bibliography, adequate references are given in the text. W. H. GEORGE.

A Revised Physical Chemistry.

Outlines of Theoretical Chemistry. By Dr. Frederick H. German. Fourth edition, revised and partly rewritten. Pp. xiii + 728. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1927.) 18*s.* 6*d.* net.

THE principal value of a review of a new edition of a well-known book is to inform the reader of the review of the features in which the new edition differs from the old. In the present instance the author claims: "a fuller treatment of limiting densities and vapour pressures; a brief description of the latest and most accurate method of measuring heats of vaporisation; a more comprehensive treatment of crystal structure and the methods of X-ray analysis; an enlargement of the section treating of the absorption of light and its bearing on chemical constitution; a thorough revision of the chapter on the elementary principles of thermodynamics; a more discriminating treatment of the phenomena of osmosis; the inclusion of the concepts of fugacity and activity in connexion with the subject of vapour pressures of dilute solutions; a fuller discussion of the theories of emulsification and gel formation; an enlargement of the sections devoted to adsorption and the methods of preparation of colloids; a more detailed account of the theories of catalysis; the treatment of the more important practical applications of conductance and electrometric methods in separate sections in the respective chapters devoted to electrical conductance and electromotive force; the simplification of the treatment of hydrolysis; the adoption of a uniform and consistent system for the representation of galvanic cells, thereby connecting their polarity with the direction of current-flow; a fuller treatment of both the hydrogen electrode and oxidation and reduction cells; the rearrangement and enlargement of the chapter on electrolysis and polarisation; a brief presentation of the quantum theory together with its application to

the principle of photochemical equivalence; an outline of Baly's fascinating and suggestive researches in the field of photosynthesis; and lastly, the complete revision of the chapter on atomic structure."

There can be little doubt that further changes will have to be made in the near future when the author has considered in fuller detail how far he intends to maintain his hold upon Arrhenius's theory of reversible ionisation and how far he proposes to admit the later theory of complete ionisation, since it is obviously unsatisfactory to devote a large part of one chapter to expounding one view and a considerable part of another chapter to demolishing the foundations on which that view rests. The optical sections of the book will also require revision, in order to conform to the modern physical view that absorption of light of given frequency does not depend on a vibratory oscillation of given frequency in the molecule, but on the possibility of some form of activation in which quanta of energy of suitable magnitude are taken up.

These two points serve to illustrate the difficulty that is experienced by every writer of books on physical chemistry in this transition period, and they are particularly acute when a book of well-established merit falls due for revision. The author has not spared himself in the work of revision, and, if further changes have to be made in the near future, this will only be a further proof of the vitality of the subject which he expounds with no mean skill.

Our Bookshelf.

Allen's Commercial Organic Analysis. Vol. 5: *Tannins, Writing Inks, Stamping, Typing and Marking Inks, Printing Inks, Amines and Ammonium Bases, Analysis of Leather, Colouring Matters of Natural Origin, Colouring Substances in Foods, Benzene and its Homologues, Aniline and its Allies, Naphthylamines, Pyridine, Quinoline, and Acridine Bases.* By the Editors and the following Contributors: M. Nierenstein, C. Ainsworth Mitchell, John B. Tuttle, H. E. Cox, A. E. Caunce, W. M. Gardner, Walter E. Mathewson, J. Bennett Hill, A. B. Davis, Fifth edition, revised and in part rewritten. Editors: Samuel S. Sadtler, Dr. Elbert C. Lathrop, C. Ainsworth Mitchell. Pp. xii + 700. (London: J. and A. Churchill, 1927.) 30*s.* net.

IN the period of sixteen years since the publication of the corresponding volume in the fourth edition of "Allen's Commercial Organic Analysis," there has been a considerable advance in our knowledge of practically all the sections under review. In spite of the enormous amount of data to be included on a great number of subjects in a limited space, the editors have presented a readable and connected book. They have avoided the temptation of presenting their material in the usual dull dictionary form now so common in many comprehensive treatises on specialised branches of science.

Benzene and its homologues have been introduced as a first step on the road to coal-tar dyes, and are considered before dealing with amines and other dye intermediates. As natural dye colours are used largely as foundation material for the after treatment with coal-tar colours, they are included in this volume. Tannin materials and inks are considered in conjunction with natural colours which are rich in tannin products. Nearly one-third of the whole volume deals with the subject of tannin, and the qualitative and quantitative examination of tannin materials is treated exhaustively. The constitution of acacatechin, as set forth by Nierenstein, is given, and while it is stated that this is not in agreement with the views of Freudenberg, it is left to the reader to look up the original papers, to which references are given, to examine the points of difference.

Much of the material in the sections on amines and ammonium bases, benzene and its homologues aniline, naphthylamine, etc., will be found in general text-books on organic chemistry. If this material was restricted, more place might be given to the more specialised sections on natural colouring matters, inks, and leather analysis.

The volume shows signs of careful editing, and only a small number of errors have been noted. The standard of the previous volumes has been maintained generally, and the subject index has been greatly improved. J. REILLY.

(1) *Manual of British Birds.* By H. Saunders. Third edition, revised and enlarged by Dr. William Eagle Clarke. Pp. viii + 834. (London and Edinburgh: Gurney and Jackson, 1927.) 30*s.* net.

(2) *The Birds of the Island of Bute.* By J. M. McWilliam. Pp. 128 + 8 plates. (London: H. F. and G. Witherby, 1927.) 8*s.* 6*d.* net.

(1) CLOSE field observation and keen discrimination of racial differences have brought the number of British birds from 384 to 500 since the second edition of this famous "Manual" appeared twenty-eight years ago. Fortunately, the bulk of the third edition has not kept pace with the increase, for although all the additions are described and many are illustrated, the editor has properly distinguished between rare visitors and regular British birds by allotting less space to each of the former. The essential plan is as in earlier editions: the occurrence in Britain, characteristic appearance, nesting habits, and migrations of each species are set out in a description which, with an illustration in woodcut or half-tone, occupies roughly two pages.

Great care has evidently been taken in compiling the accounts of occurrences and breeding in the British Isles, one of the most useful features in

the book, since records are brought down to the year of publication. Its compactness in a single volume, its accurate, full and readable descriptions, and its definitive illustrations of every species, make this the most suitable of British bird books for the ordinary ornithologist and naturalist.

(2) Island faunas offer many points of interest to the naturalist, and although the viability of birds discounts the significance of many species, there remains a substratum of 'residenters' which illustrate, more clearly than can be done on the mainland, the history of the fauna. Mr. McWilliam fully appreciates this significance, and in his historical introduction and remarks about several species, points out how the island of Bute has suffered a gradual reduction. In all, 168 species have been recorded from this limited area, and a general survey shows that the avifauna is closely comparable with that of the mainland, although island life has sometimes impressed new habits. Thus of rooks, jackdaws, and starlings, it is noted that they make daily migrations to the mainland over the Firth of Clyde, setting out in the morning and returning at dusk, notwithstanding that Bute itself apparently contains abundance of suitable feeding ground. It is estimated that in the autumn the sixty square miles of the island may contain as many as 400,000 birds.

A Treatise on the British Freshwater Algæ, in which are included all the Pigmented Protophyta hitherto found in British Freshwaters. By the late Prof. G. S. West. New and revised edition, in great part rewritten by Prof. F. E. Fritsch. Pp. xviii +534. (Cambridge: At the University Press, 1927.) 21*s.* net.

MORE than twenty years have elapsed since the late G. S. West published his "British Freshwater Algæ." The edition was soon exhausted, and the lack of a similar volume has since been acutely realised. Prof. Fritsch has, therefore, done botanists in general a very real service in undertaking a revision of the earlier work. He has successfully tried to retain the character of the original volume, but the vast increase in every branch of our knowledge of the algæ has necessitated the addition of an enormous mass of material, and the result is an entirely new work, which has gained also an added personality.

Point is given to the general treatment of algal morphology in the emphasis laid on the development of parallel stages of morphological complexity in widely separated groups, a useful chart being given in illustration. The chief changes in arrangement occur in the Isokontæ. The Cladophorales and Sphæropleales are now removed from the Siphonales and grouped with Ulothricales, presumably on account of their metabolic similarity. The treatment of the Chlorococcales follows that of Brunnthaler in distinguishing Autosporinæ and Zoosporinæ. A considerable number of flagellate forms are added, these being grouped along with the appropriate coccoid and filamentous forms. The Peridineæ are also now included. No freshwater Phæophyceæ are recognised, the forms which were formerly described here having been more suitably transferred to the Chrysophyceæ.

The figures include one, at least, of every genus. Generic keys are given, and indications of the characters of at least the commoner species, while the valuable indications as to habitat have been retained and amplified. The book will be of great value not only to the algologist, but also to the teaching botanist, the student, and the amateur naturalist. W. H. P.

Foremanship Training. By Lieut.-Col. Hugo Diemer. Pp. viii+230. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1927.) 12*s.* 6*d.* net.

THE *flair* for business which is so typical of Americans is peculiarly noticeable in their methodical consideration of the problem, how to get the most effect out of men and materials. This does not imply that the American seeks to take advantage of his fellow-citizens; it is rather that he desires to use human effort (as he strives to use mechanical effort) to the last ounce of advantage, so that the end in view may be achieved in the most practically economical way. Col. Hugo Diemer's treatise upon foremanship training considers one—and a very important—aspect of this urge for maximum effect. In a series of fourteen chapters he discusses that responsible cog in the machine, the foreman, with the view of making evident the necessity for training him so as to be, in fact, something more than a mere part of a machine—to be a man with intelligent general grasp of the whole of the work involved, and having a human faculty for bringing out what is best in the employés over whom he has to exercise a measure of control. The author drives home his arguments with a skill that is beyond dispute.

P. L. M.

A Book of Words: Selections from Speeches and Addresses delivered between 1906 and 1927. By Rudyard Kipling. Pp. vii + 299. (London: Macmillan and Co., Ltd., 1928.) 7*s.* 6*d.* net.

THE addresses which compose the "Book of Words" were delivered in many lands to varied audiences through a period covering almost a quarter of a century. Occasional speeches, however, especially when delivered in lighter vein, only have value outside the circumstances in which they are made when they contain, hidden it may be by phraseology peculiar to the occasion, ideas of general interest. Such, in a measure, are these speeches. Almost every conceivable theme is touched upon from "The Spirit of the Navy" to the "Virtue of France," from "Independence" to the "Handicaps of Letters." Here and there, at greater length, occur other types of topics such as the contribution of prehistoric man to modern military practice and naval science, in which imagination and a kindly regard for half truths have resulted in charming narratives. The delight of the book is in the reading.

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.*]

Lecture Experiments on the Hydrogen Ion Concentration Changes in the Rusting of Iron.

FOR the rusting of iron, oxygen, water, and a trace of acid are required. In the process oxygen is used up, also a certain amount of water, but the acid may be said to act as a catalyst. It is, in fact, regenerated when the ferrous salt first formed is oxidised to the ferric state, as was shown previously (*Trans. Faraday Soc.*, **18**, 310-317; 1923). This is at once evident when we consider that, on making solutions of ferric or ferrous salts less acid, ferric hydroxide is first precipitated, at *p*H 3·5 to 5·5, and ferrous hydroxide comes down later, at *p*H 5·1 and onwards, a trace being still in solution at *p*H 7·6. Oxidation, therefore, must result in a liberation of acid, accounted for by the ferric being hydrolysed to a greater extent than the ferrous salt.

The reaction may be demonstrated as follows: Adding four drops of 0·04 per cent. brom phenol blue to each 10 c.c. of a dilute solution of a ferric salt, the yellowish colour of the indicator denotes acidity equivalent to *p*H 3·2 or less, namely, equivalent to a solution at least as acid. A similar solution of ferrous sulphate gives a purple colour with this indicator and can accordingly be no more acid than *p*H 4·2. It is in reality at about *p*H 4·8. On standing for some days the change to the ferric condition is accompanied by a change in reaction, as shown by the indicator. For lecture demonstration, however, it may be brought about instantaneously. By adding a few crystals of 'hyperol' to distilled water, a solution of hydrogen peroxide may be prepared which is no more acid than *p*H 5·6. It is accordingly alkaline towards the indicator mentioned and gives with it a good purple colour, as does also the freshly prepared ferrous solution. On mixing these two alkaline solutions, the result is a solution acid to the indicator, namely, at about *p*H 3·2, which is a clear yellow. This somewhat paradoxical behaviour is accounted for by the regeneration of acid from the hydrolysis of the ferric salt. Were metallic iron present, this acid would be free to attack it.

The action of carbon dioxide in solution can also be demonstrated. Bright iron wire is carefully washed free from the lime in which it is stored, being finally dipped in dilute acetic acid and thoroughly washed with distilled water. It is then placed in a test tube with distilled water to which brom thymol blue (0·04 per cent.) has been added. The full yellow colour of the indicator denotes the presence of free carbonic acid, so that the water is at least as acid as *p*H 6. This indicator changes to a clear green at *p*H 7·0 and is blue by *p*H 7·3. To demonstrate the rapidity of the change, one must work near the neutral point and in an unbuffered solution; the water is therefore brought to a yellowish green colour, *p*H 6·6–6·8, by the addition of either a trace of pure sodium bicarbonate or a few drops of sea water. On standing, the very low acidity, *p*H 6·8, is reduced by the attack on the iron; within two minutes the reaction has become noticeably less acid; within five minutes the change is readily recognised. For lecture demonstration the experiment may be started an hour beforehand, when the green colour of the indicator will have been changed to an intense blue round the wire. On shaking up, the whole tube becomes blue, but on allowing to stand, a green colour reappears in the parts remote from the wire, especially near the surface, owing to the oxidation of the ferrous salt, with regeneration of acid. Inasmuch as increase in acidity appears to slow down the rate, there are reasons for thinking that the constituent most readily oxidised is the fraction of the ferrous salt which is hydrolysed to hydroxide. By its oxidation the equilibrium is upset and more ferrous bicarbonate hydrolysed to hydroxide, the equivalent of acid being set free. The changes occurring round the wire may be projected on a screen and so made visible to the audience.

With solutions which are alkaline at the start, namely, those containing fewer hydrogen ions than does *pure* water, the change proceeds, though more slowly. Using 0·02 per cent. phenol red, a pink colour may be obtained, increasing to a good red, indicating *p*H 8. Using xylenol blue, a light blue may be obtained, showing a reaction as alkaline as *p*H 8·4–8·6. Beyond this I have not succeeded in going, for the change being much slower, the liberation of acid through oxidation prevents further increase in alkalinity. Were care taken, however, to remove all oxygen, it seems likely that a greater alkalinity could be reached.

On standing in a tube with distilled water, iron wire in rusting continues to absorb carbon dioxide from the air to such an extent that when the acid is set free by 'hyperol' solution, as previously described, the solution, originally no more acid than *p*H 5·6–6·0, will give a good red colour with methyl red, showing that it is nearly saturated with carbon dioxide and is somewhere near *p*H 4·6.

Control tubes without the iron wire were used throughout and the tubes were of British resistance glass. The water was freshly distilled in a room free from chemical fumes.

The explanation given here of the mechanism of the rusting of iron is, I believe, that which is now generally accepted, and the hydrogen ion changes revealed by the indicators support it. It naturally follows that the experiments described are against the view that an oxidation of the iron is the first stage in rusting.

W. R. G. ATKINS.

Marine Biological Laboratory,
Plymouth, Mar. 13.

The Disintegration of Radium E from the Point of View of Wave Mechanics.

ELLIS and Wooster (*Proc. Roy. Soc.*, A, **117**, p. 109) have shown recently that in the disintegration of radium E the single β-particle emitted has an *initial* energy which may vary from 40,000 to 1,050,000 volts. This means that the result of disintegration is in some way indeterminate, a conclusion difficult to reconcile with the usual ideas of radio-activity.

Some such result, however, is to be expected on the new wave mechanics, if the ejection of a β-particle is produced by anything like a sudden explosion. In such a case one would expect that the wave-group which accompanies, and on some views actually constitutes, the electron, would be of the nature of a single pulse, that is, the damping factor of the amplitude would be of the order of the wave-length. Such a wave-group, being very far from monochromatic, would spread rapidly lengthwise owing to the large dispersion of the phase waves, and so the distance within which the electron may occur becomes large, implying a marked 'straggling' in velocity. Similarly, if the waves pass through a magnetic field,

which is for them a refracting medium, the group will split into monochromatic waves going in different directions, just as white light is split up by a prism. Thus an observer who forms the magnetic spectrum of the β-rays will find electrons in places corresponding to paths of various curvatures, that is, he will find a spectrum continuous over a wide range.

This view can be checked numerically. Darwin has shown (*Proc. Roy. Soc.*, A, **117**, p. 258) that if we assume, for convenience of calculation, a distribution of 'intensity' (chance of the presence of an electron) in the initial wave of $\exp -(x-x_0)^2/\sigma$, that is, an 'uncertainty of position' σ, then there is an 'uncertainty of momentum' in the group of amount $h/2\pi\sigma$ and conversely. This is, of course, Heisenberg's 'uncertainty relation' in wave dress. I find that a fair fit to Ellis and Wooster's result is got by taking the number of β-particles with momentum g proportional to $\exp -\left[\frac{g-1{\cdot}25m_0c}{0{\cdot}65m_0c}\right]^2$. Hence the uncertainty in momentum is $0{\cdot}65\ m_0c$, and that in position is $\sigma = h/2\pi \times 0{\cdot}65m_0c$.

The mean wave-length by de Broglie's relation is $\lambda = h/1{\cdot}25m_0c = 2\times10^{-10}$. Thus, $\lambda = 3{\cdot}3\sigma$ and the wave is heavily damped, the amplitude at the first minimum being only 7 per cent. of that in the middle of the group. The group in fact looks like a typical pulse such as may be formed in a stretched rubber cord by a sharp blow. It should be noticed that the value of σ is much larger than the diameter of the nucleus, which might at first sight be expected to govern the uncertainty of position.

G. P. THOMSON.

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April 2.

The Form of the Carbon Atom in Crystal Structure.

A. GERSTÄCKER, H. Möller, and A. Reis have published an account of the crystal structure of pentaerythritol tetra-acetate (*Zeitsch. f. Kryst.*, **66**, 355; Jan. 1928), in which they assign the crystals to the space-group C^3_{4h} with a simple tetragonal lattice (Γ_t). There are two molecules of pentaerythritol tetra-acetate to the unit cell and the space-group C^3_{4h} with a Γ_t lattice requires eight asymmetric molecules per unit cell. Therefore the molecules of pentaerythritol tetra-acetate must have some kind of fourfold symmetry. There are two types of fourfold symmetry possible in this space-group—either a simple fourfold rotation axis or a fourfold alternating axis. Messrs. Gerstäcker, Möller, and Reis have chosen the former, since it leads to a molecule which can be built into a chain-like structure, and the latter does not.

The authors base their expectation of a chain structure on the prismatic habit of growth and on the shortness of the c-axis compared with the a-axis ($c:a = 0{\cdot}458$), and claim that a chain structure, when present, has the length of the chain parallel to the axis of highest symmetry of the crystal. Now experience goes to show that prismatic growth and chain structure are not necessarily associated, either in the tetragonal system or in any other. There are many thin tabular crystals, which have a chain structure in which the chains are perpendicular to the plates, as, for example, the many long-chain carbon compounds, which have been investigated by X-rays. Moreover, in these long-chain compounds the direction of the chains was found to be perpendicular and not parallel to the axis of highest symmetry. Again, the interesting group of metallic tetraphenyl compounds (W. H. George, *Proc. Roy. Soc.*, A, **113**, 585; Jan. 1927), which crystallise in the tetragonal system, are prismatic in their habit of growth, but show no suggestion of a chain structure.

The form of the molecule of pentaerythritol tetra-acetate proposed by the above authors is shown in Fig. 1 (reproduced from Fig. 1 of their paper). It will be seen that the molecule is polar, and that the four bonds from the central carbon atom must be directed away from it towards a square base. It does not appear that the authors have put forward any evidence which could justify the adoption of a molecular form departing so completely from what would be expected from physical and chemical considerations.

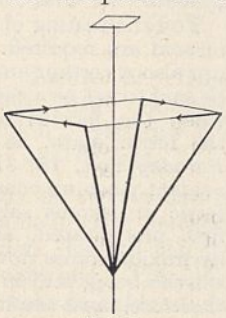

FIG. 1.

In May 1927, in a private communication to the Council of Girton College, I gave an account of an X-ray examination of pentaerythritol tetra-acetate carried out in this laboratory. My results led to the space-group C^4_{4h} and not to C^3_{4h}. The distinction between the two space-groups depends on the absence or otherwise of all odd order reflections from the (001) plane. I have been able to find only a second order reflection from this plane, after making a most careful search for other orders both on the ionisation spectrometer and by photographic methods. In a rotation photograph about the [100] axis, using copper radiation, a weak spot is found on the zero layer line, which, from its position, might be due either to the first order reflection from the (001) plane for copper $K\alpha$ rays or to the first order reflection from the (011) plane for copper $K\beta$ rays. However, in a rotation photograph about the [110] axis, the spot did not appear on the zero layer line. The conclusion is that it is not due to reflection from the (001) plane, for if it were, it should still be found in the same position as before.

In their paper, Messrs. Gerstäcker, Möller, and Reis state that they find a first order reflection from the (001) plane and are thus led to the space-group C^3_{4h}. Their only mention of this reflection is in an oscillation photograph in which [100] is the rotation axis, but neither the range of the oscillation nor its angular relation to any plane appears to be stated. It is not possible to say with certainty, therefore, to what plane the observed reflection is due, or that it is not due to the $K\beta$-reflection from the (011) plane. It is not evident that the authors have taken any particular care to establish the presence of the first order (001) reflection, upon which their space-group and, moreover, the molecular symmetry which they propose, depend. For if, as I believe, the space-group is C^4_{4h}, there is no longer any possibility of a molecule with a simple fourfold axis of symmetry, the only possible molecular symmetry then being a fourfold alternating axis, the molecule having the form shown in Fig. 2. On this view, therefore, the carbon atom plays the part expected of it.

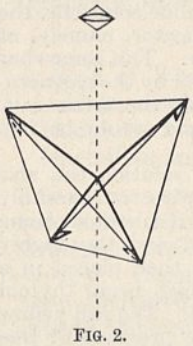

FIG. 2.

My measurements of the dimensions of the unit cell differ from those of the German workers. They find $a = 12{\cdot}34$ A., $c = 5{\cdot}56$ A., while the values I find are $a = 11{\cdot}98$ A., $c = 5{\cdot}47$ A. The density of the substance is 1·273. In a previous paper of mine (*Jour. Chem. Soc. Lond.*, **123**, 77; 1923) an overlooked printer's

error made it 1·213. With my figures and the correct value of the density, the number of molecules in the cell works out at 1·99. I. E. KNAGGS.

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Science and Nature.

IT is undeniable that the attitude towards Nature which inspired the author of NATURE'S motto, is implicitly repudiated by many of its readers. For that spiritual intimacy between Nature and man, which formed the substance of Wordsworth's poetry, is questioned and even rejected by a large body of investigators. To them Nature is the sphere of essentially impersonal energy and law, which are either absolutely indifferent or actively hostile to human ideals. Huxley, for example, regarded the 'cosmic process' as everywhere antithetic to 'social progress,' thus unconsciously destroying the continuity of evolution just where it becomes of supreme value to humanity; and in precisely the same spirit Mr. Bertrand Russell foresees the ultimate extinction, by natural agencies, of everything for which he himself bids us strive.

The validity of such a viewpoint is plainly a matter of the highest scientific importance. For since science is the investigation of Nature, any interpretation of Nature must reflect itself in the interpretation of science itself. Conversely, the implications of science must illuminate the character of Nature; so that quite apart from that fatal breach of evolutionary continuity postulated by Huxley, both the content and the expansion of modern science yield ample material for controverting his conclusion. From the strictly psychological viewpoint, all functions of the human mind are fully as natural as those of the brain. It follows, therefore, that reason, logic, and science are just as natural as the cerebral processes which sustain them; and even if any of these are 'emergent,' still this involves no essential loss of continuity. Thus Nature is not only the *object* of science, but also the sole and primal *source* of science; and this, still further, not in any merely passive nor indifferent way, but dynamically. For it matters not whether man's intellect is the result of heritable acquired characteristics or of natural selection, since in both respects alike it is the culmination of the age-long interplay of Nature's own agencies. Reason, then, is in no degree foreign to Nature; Nature therefore cannot be foreign, much less hostile, to reason and all that reason involves—to science, art, and morals. Only thus, in fact, can NATURE'S motto be accepted in anything beyond a purely metaphorical sense.

Turning next to the specific content of science, it is clear that the logic of science reflects an order of Nature. This remains true even if we regard scientific principles as mere formulæ which enable man to utilise and control Nature; the sole alternative being the abdication of thought in favour of Bergsonian 'intuition,' which is plainly suicidal so far as science itself is concerned. The truth surely is that science yields an insight, slowly growing in clarity and coherence, into the structure of Nature alike on its physical, vital, and psychical levels. To what degree these are continuous with one another is an important, but here subordinate, problem, since it cannot affect the conclusion that Nature, not partially but throughout its whole extent—from electron to galaxy, from space-time to Shakespeare—is coterminous both with human reason and, so far as man dominates Nature, with human purpose.

It may still be argued that this reciprocity is approaching its final limits, beyond which lies Nature not merely as unknowable, but as inimical. This suggestion, however, definitely contradicts the incessant *expansion* of modern science. For in all its details alike, scientific progress exemplifies the single fundamental principle that Nature possesses a structure and order so systematic and intricate, so delicate and precise, that all current theories are far too simple to be at all adequate for their understanding and explanation. The solution of every problem without exception reveals fresh problems of ever-increasing difficulty; but in spite of this, increased knowledge shows these to be, in principle, soluble problems. In other words, they are not, essentially, intractable to human reason as such, but only to the limited data with which reason, at any given stage, is condemned to operate; so that as these data slowly multiply, to that degree can more of Nature's riddles be read. Reason thus proves itself to find an ever-widening and favourable habitat within Nature's inmost realm, which thus reveals itself to be no hostile region, but rather thought's highest native sphere.

Nevertheless, the relation between science and Nature must always remain asymptotic; it can never become exhaustive. But this again is no occasion for pessimism and despair. Rightly understood, on the contrary, it plainly implies that Nature, far from mocking and defying human thought, beckons it ever onward to more intimate contact with herself. For her last secrets will be disclosed only to a reason and a science which transcend our own to the same degree that we transcend Eoanthropus.

J. E. TURNER.

Light and Sight.

I HAVE read Sir John Parsons' article in NATURE of Jan. 21 and the letters of Mr. Smith and Sir John (NATURE, Feb. 18) with great interest. Perhaps I may be allowed to make a few comments on them. Sir John's supposition was that since the retinal sensation curve reaches its maximum not far from that of the energy curve, and since the two curves are not unlike in shape, there may have been some evolutionary process at work. Mr. Smith's criticism is that only on a wave-length basis would this be the case. If, as is preferable, frequencies be taken, then the shapes of the two curves are quite different.

Now we cannot be sure that Mr. Smith's criticism is justified until we have considered the conditions present in the eye. Until we have done that, have we a pertinent reason for claiming one set of arbitary units (wave-lengths) to be better or worse than another set (frequencies)?

Now on a wave-length basis, equal wave-length differencies occupy equal areas and all wave-lengths have equal access, since the slit remains fixed in size to give equal wave-length purity. On a frequency basis, on the other hand, equal wave-length differencies do not occupy equal areas, since those of long wave-length are more condensed and those of shorter wave-length more spread out. Neither have all wave-lengths equal access, since the slit has to be narrower for short wave-lengths than for long, to give equal frequency purity.

In the eye, on the other hand, owing to the presence of chromatic difference of magnification, shorter wave-lengths are less spread out, and the pupil is slightly wider for short wave-lengths than for long. That is, the conditions present are far removed from the frequency basis and approximate fairly closely to the wave-length one. In view of this, I can see no reason to prefer the frequency basis or to criticise Sir John's suggestion as being impossible. With

regard to Mr. Smith's alternative suggestion that the use, on one hand, of the near ultra-violet rays has been avoided in vision because of want of contrast, and of the near infra-red rays, on the other, because of the blackness of the shadows: if there were such difficulties in the use of these rays, one would expect ordinary non-colour-sensitive photography to be adversely affected on one hand, and for these black shadows to become visible when the eye is made sensitive to rays between 6800 and 7100 A. on the other.

Yet in my experience such is not the case. Is it not conceivable that the blackness of the shadows was due in R. W. Wood's photographs to slight under-exposure, seeing that only recently have fast infra-red sensitive plates been available. To my mind, it is more likely that the exclusion of ultra-violet rays was due to the difficulty in producing living media transparent to these rays, and that the non-utilisation of the near infra-red rays (which do in point of fact reach the retina) is due to the absence of a suitable retinal pigment which will absorb and will undergo photo-chemical change as a result of the incidence of these rays. Now I will refer to the resolving power of the eye. Mr. Smith suggests that there are ocular powers of discrimination that are more refined than the coarser features of retinal structure—the rods and cones—would lead us to expect. This is a question to which I have given a great deal of thought, and the conclusion to which I have come is that if we are prepared to grant that the cones in some way are able to register increases or decreases of intensity of, roughly, 10 per cent. (which we should not find difficult, since we can prove by experiment that moderate sized areas of retina can register increases or decreases of intensity of less than 1 per cent.), then we can adequately account for all the finer ocular powers. We can explain on this basis how, for example, the eye that can just recognise the 'twoness' of two point sources when they subtend at the eye an angle of not much less than 50″, can see a black line when its width subtends at the eye an angle of only 3·1″; with cones, moreover, the diameters of which subtend at the nodal point of the eye an angle of about 44″.

Lastly, with regard to Mr. Smith's letter in NATURE of Feb. 25 on "An Optical Paradox," would not any method of measurement depending on comparisons break down if put to a similar test? I would propose that the word 'optical' be omitted lest it suggest to the uninitiated the idea that the paradox only applies to visual measurements.

H. HARTRIDGE.

The Density necessary to Produce the Nebular Spectrum.

IN a recent letter to NATURE (Jan. 7, p. 12) C. T. Elvey attempts to calculate the density, ρ, of the expanding gaseous shell of a nova at the moment when the nebular lines first appear. It is easily shown that $\rho = \rho_0 r_0^2 / v^2 t^2$ where ρ_0 is the original density of the shell when coincident with the stellar atmosphere, r_0 its original radius, v its velocity of expansion, and t the time elapsing between the outburst and the appearance of the nebular lines. The above equation involves the additional and somewhat questionable assumption that the thickness of the expanding shell does not change. Elvey takes v from velocity displacements on nova spectrograms. For Nova Aquilæ 3 this is about 1700 km./sec. and $t = 19$ days. Hence he finds,

$$\rho = 12{\cdot}7 \times 10^{-20} \rho_0 r_0^2 \text{ gm./c.c.}$$

(r_0 in km.). Since figures for eight additional novæ give coefficients for $\rho_0 r_0^2$ of the same order of magnitude, Elvey concludes that "the novæ originate from stars of similar physical conditions and that there is a limiting density above which the conditions are unfavourable for the production of the nebular spectrum."

It is my opinion that the experimental evidence is far too meagre to draw any further conclusions than those just quoted. Up to this point the assumption of constant thickness for the gaseous shell has been unnecessary. It would have been sufficient merely to suppose that it varies at the same rate for all novæ.

I think that Elvey's attempt to calculate an absolute value for ρ is not justified. Taking $\rho_0 = 10^{-9}$ gm./c.c. (corresponding to a pressure of some 10^{-4} atmosphere) and $r_0 = 6 \times 10^5$ km., he finds for the mean density, critical to the nebular lines, $1{\cdot}8 \times 10^{-17}$ gm./c.c. Elvey's use of $\rho_0 = 10^{-9}$ gm./c.c. is equivalent to the assumption that the phenomenon of the nova originates in that particular layer of the star's atmosphere. There is no *a priori* reason why a value of ρ_0 of 10^4 or more times the above should not have been employed in the calculation; the expanding shell would still be essentially atmospheric. It is true that the value, 10^{-4} atmosphere, is the pressure at which the stellar atmosphere is becoming opaque to visible radiation and hence marks a more or less definite layer, but this fact does not demand that all atmospheric phenomena originate there.

Bowen (*Publ. A. S. P.*, **39**, 295; 1927) has identified the nebular lines with metastable transitions in the atoms of singly, doubly, and triply ionised oxygen. These transitions, at one time spoken of as 'forbidden,' are presumably allowed in the very tenuous nebulæ, where the time between atomic collisions is extremely long. Ordinarily the time spent by an electron in an excited level is only about 10^{-8} sec. The time it would remain in a metastable state is much greater—so long, in fact, that before the natural atomic transition can occur, a collision with another atom (impact of the second kind) will knock the electron from its metastable orbit. Hence the 'forbidden' electron jumps should occur only when the time between collisions is longer than the excited time, that is, in gas of low density. A determination of the critical density, at which the metastable transitions begin to occur, would furnish valuable information regarding their life-time, but Elvey's value for it—a hundred seconds—is almost valueless for the reasons stated above.

The only fact that recommends Elvey's computed densities appears to be the close correspondence between them and the calculated values[1] for the planetary nebulæ (5×10^{-18} gm./c.c.). If the latter be assumed approximately true for the novæ, the more correct interpretation of Elvey's work is that the phenomenon of a nova originates in the star's atmosphere at a layer where the pressure is 10^{-4} atmosphere or less. When more data regarding the life histories of novæ have been obtained, and when the physicists have determined the metastable life of the atoms under consideration, these facts may be used to solve the nova problem. One should not neglect, however, to take into account photo-electric ionisation of the gas by the intense stellar radiation. Recent work by Bowen (*Astrophys. Jour.*, **67**, 1; 1928) shows that conclusions derived without considering this influence may be devoid of physical meaning.

DONALD H. MENZEL.

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Mar. 14.

[1] Russell, Dugan, and Stewart, "Astrophysics and Stellar Astronomy," p. 835.

An Apparent Failure of the Hund Theory.

THE Hund theory of spectra includes, as an essential part of it, a prediction of the individual levels of an ion to which component term sequences will converge. The evidence supporting the predictions seem reasonably good in cases of spectra the character of which is determined by less than half-filled electron groups. On the other hand, the following two items of evidence seem to indicate that the theoretical predictions are not fulfilled in spectra determined by nearly completed electron groups.

1. The Paschen s terms in Ne I are, without doubt, the ^3P and ^1P, which arise from an electron structure $2p^5ns$ ($n \geq 3$). The $1s$ terms can be arranged unambiguously from both position and Zeeman effect as follows:

$$^3P_2 = 1s_5,\ ^3P_1 = 1s_4,\ ^3P_0 = 1s_3,\ ^1P_1 = 1s_2.$$

Consequently, if one accepts Paschen's series, $^3P_2$ and $^3P_1$ converge to one limit; and $^3P_0$ and $^1P_1$ to a higher limit, the two limits together being the $^2P(p^5)$ of Ne II. This is in definite disagreement with the theory, which would reverse the limits of $^3P_1$ and $^1P_1$. Since the nature of the terms is determined empirically in this case by the first members only and the limits by the higher members, it is possible to reconcile observation and theory, as Hund has done, by associating $1s_4$ with the s_2 series as its first member; and $1s_2$ in the same way with the s_4 series. But there is now evidence against such a change. The series of s_2 and s_4 terms combine with the lowest term of the spectrum $^1S_0\,(2p^6)$ to give a far ultra-violet series of pairs $^1S_0 - ns_2$, $^1S_0 - ns_4$. In this series the line $^1S_0 - ns_2$ is the stronger of each of the pairs. This statement is based not only on the published material, but also on personal observation of plates taken in this laboratory. Such a regularity of intensities is incompatible with Hund's distortion of the series and leads definitely to the conclusion that the theoretical prediction is not satisfied for such sequences as the s-terms of neon. The whole argument applies equally to the corresponding terms of argon.

2. The second item of evidence is contained in the spectra of atoms and ions, of which the structure is based on 9 d-electrons. Ni I, Cu II, Pd I, Ag II all show sequences of ^3D, ^1D terms of origin d^9s converging to the $^2D(d^9)$ of the higher ion. In Cu II, Ni I, and Ag II only two series members are known, but they are well verified in every case by intensities and in Cu II also by Zeeman effects. In all cases the calculated limits of $^3D_3$ and $^3D_2$ fall close together, as do those of $^3D_1$ and $^1D_2$, contrary to the theory, which predicts coincidence of the limits in pairs $^3D_3$, $^1D_2$; $^3D_2$, $^3D_1$. In Pd I the evidence is more striking, since three series members are present. To pick them correctly, it is necessary to identify consistently all the terms of the spectrum from intensities. This leads to an identification of the middle set of terms exactly as given by Bechert and Catalan and in disagreement with McLennan and Smith. The second member of the d^9s sequence is then McLennan's with $^3D_2$ and $^1D_2$ interchanged. In the third member, this interchange is again necessary, and also the addition of McLennan's $^3G_4$ as $^3D_3$. These identifications are unambiguous. The limits calculated from a Ritz series formula lead to the same disagreement with theory as the similar two term series. The separation of the two limits $^2D_3$ and $^2D_2$ of Pd II, is so great (more than 3500 wave-numbers) that there can scarcely be any doubt of the reality of the coincidences of the real limits even though the calculated limits differ by 80 units in one case ($^3D_3$ and $^3D_2$) and 20 units in the other ($^3D_1$ and $^1D_2$).

The disagreements with the Hund theory here pointed out are the only ones of which I am aware. More evidence is certainly advisable and it is being sought in this laboratory.

I cannot offer any explanation of these apparent failures of the theory. It seems that the operations with the electron vectors which lead to the predictions may be carried out in a great variety of ways and lead always to the same result so long as they are treated consistently in both series and limit terms.

A. G. SHENSTONE.

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Feb. 16.

A Change of Wave-length in Light Scattering.

FURTHER observations by Mr. Krishnan and myself on the new kind of light-scattering discovered by us have been made and have led to some very surprising and interesting results.

In order to convince ourselves that the secondary radiation observed by us was a true scattering and not a fluorescence, we proceeded to examine the effect in greater detail. The principal difficulty in observing the effect with gases and vapours was its excessive feebleness. In the case of substances of sufficient light-scattering power, this difficulty was overcome by using an enclosed bulb and heating it up so as to secure an adequate density of vapour. Using a blue-violet filter in the track of the incident light, and a complementary green-yellow filter in front of the observer's eye, the modified scattered radiation was observed with a number of organic vapours, and it was even possible to determine its state of polarisation. It was found that in certain cases, for example, pentane, it was strongly polarised, while in others, as for example naphthalene, it was only feebly so, the behaviour being parallel to that observed in the liquid state. Liquid carbon dioxide in a steel observation vessel was studied, and exhibited the modified scattering to a notable extent. When a cloud was formed within the vessel by expansion, the modified scattering brightened up at the same time as the ordinary or classical scattering. The conclusion is thus reached that the radiations of altered wave-length from neighbouring molecules are coherent with each other.

A greater surprise was provided by the spectroscopic observations. Using sunlight with a blue filter as the illuminant, the modified scattered radiation was readily detected by the appearance in the spectrum of the scattered light of radiations absent from the incident light. With a suitably chosen filter in the incident light, the classical and modified scatterings appeared as separate regions in the spectrum separated by a dark region. This encouraged us to use a mercury arc as the source of light, all radiations of longer wave-length than 4358 A. being cut out by a filter. The scattered radiations when examined with a spectroscope showed some sharp bright lines additional to those present in the incident light, their wave-length being longer than 4358 A.; at least two such lines were prominent and appeared to be accompanied by some fainter lines, and in addition a continuous spectrum. The relation of frequencies between the new lines and those present in the incident light is being investigated by photographing and measuring the spectra. The preliminary visual observations appear to indicate that the position of the principal modified lines is the same for all substances, though their intensity and that of the continuous spectrum does vary with their chemical nature.

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Calcutta, Mar. 8.

Limits of Form and Magnitude in Desert Dunes.[1]

By Dr. VAUGHAN CORNISH.

REVIEWING in the light of later publications, particularly Sven Hedin's "Scientific Results" and Dr. W. F. Hume's "Geology of Egypt," vol. 1, the observations of sand dunes which I made more than a quarter of a century ago, I have been led to recognise the dynamical significance of the peaked structure which is so marked and picturesque a character in the sand seas of the Gobi, the Tarim basin, and western Egypt.

On the sea shore, loose, dry sand is arranged by the wind in little waves, which travel and keep station with one another as they move. They are a few inches from crest to crest, with short, steep front and long, gentle slope to windward. These little æolian waves, or ripples as they are called, are remarkably level-crested and long-crested, these characters being much more pronounced than in the waves which travel on water during the action of a breeze (Fig. 1).

FIG. 1.—The level crests of æolian sand ripples.

In the extensive deposits of dry sand which are called sand seas, these long- and level-crested ripples pattern the slopes of the larger waves, called dunes. The average steepness, or ratio of height to length, of the dunes is comparable to that of the ripples but generally rather less. The profile of the large waves, or dunes, is of the same general character as that of the ripples, a short, steep front and a long, gently-sloping back; but the section at right angles to the wind is very different. A manikin viewing a landscape of æolian sand ripples would see a succession of peaks when looking across the direction of the wind, but a level sky-line when looking up- or down-wind. The drawings of M. Binosi in the western desert of Egypt, of Dr. Sven Hedin in the Takla Makan, and that made from the notes of Sir Francis Younghusband in the Gobi ("The Heart of a Continent," p. 98) show that, in whatever direction we look, the sky-line is punctuated by sharp peaks, all of which attain about the same height. Thus, whereas the little sand-waves or ripples are normally level-crested and long-crested, the large sand waves or dunes which rise from a sea of sand subject to stormy winds are usually peaked and frequently short-crested.[2] The peaked form has been ascribed to a breaking of the level-topped ridges by wind from a direction inclined, or at right angles, to that by which the ridges were built. It is evident that such seasonal change of wind would furrow the ridges and make them otherwise irregular, but from observations which I made in Egypt in 1899 I infer that peak-and-saddle form can be produced by strong wind constant in direction, and that this is in fact the form of the maximum sand waves produced by such wind in a sand sea.

On a dried-out sandbank of the Nile near Helwan, where the sand is finer and more mobile than that of the desert, I watched a group of many little dunes, about twenty inches high and thirty feet in wave-length, during the process of transformation

[1] See paper on "Waves in Granular Material Formed and Propelled by Winds and Currents," *Monthly Notices of the R.A.S.*, Geophysical Supplement, July 1927.

[2] The term 'short-crested' has been introduced by Dr. H. Jeffreys for "wave systems in which the distance between consecutive maxima of elevation is of the same order of magnitude in whatever direction it is measured."

from the level-crested to the peak-and-saddle crested form, the direction of the wind remaining constant. It can easily be understood that if the wind increase after the ridges have attained their maximum steepness the crest will collapse here and there, but the natural expectation would be that the parts then left upstanding would soon give way, thereby levelling the crest, whereas in fact the undulation of the crest rapidly increased. It follows that if any lowering at the peaks occurred, it must have been less rapid than at the saddles, but in point of fact there was no indication that any lowering had occurred at the peaks. The action of the wind, as well as I could ascertain, was as follows. In passing through the notches or saddles it neither conformed to the profile of the surface nor circulated round a horizontal axis, but swirled spirally. It is significant that the ripples at the saddles were larger and the sand coarser than elsewhere. Under the lee of the peak the right- and left-handed spirals met. When the dunes were losing more sand than they received, and the wind was strong, the action of these converging currents under the lee of the peak was to scoop out the loose sand, lowering the trough, sometimes down to the bare floor. When, however, there was no depletion, a longitudinal bank of sand was piled against the lee of the peak where the converging currents met.

I measured the height and wave-length of a long series of these dunes which had level crests, and of another series the crests of which had marked peak-and-saddle form, and found that the average steepness was the same, a result which points to the conclusion that as much sand is piled on the peaks as is eroded at the saddles.

When I crossed the Suez Canal at Kantara and went east along the El Arish route to view the sand sea of northern Sinai, I found the western edge of the buried country, where the sand is not deep, was all in rounded, billowy undulations like those of gently rolling chalk downs; but farther on, where the deposit was thicker, the dunes had the characteristic desk-shaped profile. Their ridges, however, although of considerable crest-length, were neither level nor merely undulating, but punctuated by peaks the height of which above saddle was comparable to the height of saddle above trough. The moderate breeze which was blowing daily at the time of my visit was in the reverse direction to that of the wind by which the dunes appear to be formed, not oblique or at right angles thereto. As the height of peak above trough is sometimes as much as three hundred feet, it is evident that the force of the wind at the crests must be considerably greater than that to which the sand on the shallow margin of the sand sea is exposed. This would account for the more pronounced form of profile. It is evident, however, that the increased force of wind due to vertical deflexion must set a limit to the growth of peaks: there will be a certain height at which the top will collapse.

FIG. 2.—A peak on the crest-ridge of a sand dune.

On the west side of the Suez Canal, near Ismailia and close to Lake Timsah, was a transverse ridge of dune from which rose a pyramidal peak so sharp that its appearance recalled the monumental pyramids of Egypt (Fig. 2). As I approached the peak from the lee side in order to obtain a nearer view, the vibration of my step caused a considerable landslide, the soft sand of the lee side breaking away from the crest-line where it abutted on the more compact sand of the weather slope. The accom-

panying photograph was snapped at the moment when slipping began. The occurrence emphasised the conclusion that such peaks are forms of accumulation, not erosion.

From the foregoing observations I infer that if a country be silted with loose, dry sand under the action of strong wind constant in direction until the dunes attain maximum height, the sky-line will be serrated by peaks not only when viewed at right angles to the wind but also when looking up- or down-wind; that these peaks are not remnants of erosion, but accumulations; and that the normal crest-line of maximum dunes in a sand sea subject to strong wind of constant direction is not level, but peaked.

Dr. Sven Hedin records in his "Scientific Results" that in the eastern part of the desert of Lop, the windward part of the Tarim basin, small dunes are formed during the dying-down of a storm, but when the wind gathers force in the next storm are dispersed. Mr. A. E. Douglass [3] and Prof. S. I. Bailey [4] record that in the windward part of the Peruvian desert of Islay the sand, which is derived from an extraneous source, collects in isolated dunes less than four feet high which are not permanent, being dispersed after a time, blown to pieces by the wind. As soon as a height of four feet is attained, permanence is assured, but does not occur nearer than twenty miles from the windward edge of the desert. From this position the moving mounds grow during a very short course of travel from four feet to fifteen feet in height, which is the characteristic maximum throughout the remaining twenty-five miles of desert plateau. The dimensions and movement of a dune near La Joya railway station have been recorded for several years. The rate of progress was remarkably uniform, 62, 57, 63, 63, 63 feet in successive years, and the height and breadth of the crescentic mound was almost constant. The length and direction of the tapering cusps or horns varied, but the quantity of sand added to or subtracted from the cusps was very small in proportion to the total mass of the dune, not, I think, greater than the quantity contained in one of the rudimentary dunes which form and disperse in the windward part of the desert according to the vicissitudes of weather.

It is well to bear in mind that most of the recorded observations of the movement of sand-grains in deserts have been made during moderate breezes, when the effect of a mound of sand is to provide shelter to leeward. During storms the atmosphere in a sand sea is usually so blinding and suffocating that no precise observations are made, but in this weather the increased force of wind at the summit of the dune is sufficient to cause dispersal, a reversal of the mode of action which we commonly observe.

[3] *Appalachia*, vol. 12, No. 1.
[4] *Annals of the Astronomical Observatory of Harvard College*, **29**, Part II.

High Frequency Sound Waves of Small Intensity and their Biological Effects.

By Prof. E. NEWTON HARVEY, Princeton University,
and ALFRED L. LOOMIS, the Loomis Laboratory, Tuxedo Park, New York.

R. W. WOOD and one of us (Loomis) have described (*Phil. Mag.*, **4**, 417; September 1927) certain physical and biological effects observed with high frequency sound waves of great intensity. To obtain this great intensity, high potentials (of the order of 50,000 volts) are required, and the oscillating piezo-electric quartz crystal must be operated in an oil bath. This method is not suitable for observing biological material under a microscope.

For this purpose we have constructed a special device which can be attached directly to a microscope and operated by an oscillator of relatively low power but must be accurately tuned to resonance with the quartz crystal. The entire oscillator (Fig. 1) is very compact and weighs only eighteen pounds. It takes current directly from the 110 volt A.C. lighting circuit and employs a 75 watt tube (Radiotron 852) with two small transformers (one giving 8 volts for the filament, the other 1100 volts for the plate). The microscope with quartz crystal is set up about three feet from the oscillator and connected through a shielded lead, so that movements of the operator will not materially vary the capacity and thus the frequency. Two controls which connect with the oscillator are operated from the microscope, one varying the plate and filament current and the other the frequency.

The crystal mounting consists of a bakelite ring which is placed directly on the microscope stage. Fastened to the top of this ring is a thin foil electrode connected to the high tension lead. The quartz crystal is placed on top of this electrode. The crystal is 54 mm. in diameter and 7·02 mm. thick. It is cut with its electric axis perpendicular to the plane of the disc. Its natural frequency is 406 kilocycles per second. The specimen to be examined is placed on the centre of the upper surface of this disc and protected with a cover glass. On top is placed the upper electrode, which is earthed. The frame of the microscope is also earthed. A small hole through the centre of the lower electrode permits adequate illumination of the specimen, and a similar hole through the upper electrode permits the light from the specimen to enter the microscope objective.

Observing under a high-power microscope, it has been possible to follow the progressive destruction of frog blood corpuscles. The oval cells at first become warped and twisted. Strained areas appear and the colour fades, leaving a pale distorted shadow. Human blood corpuscles are likewise twisted and sometimes broken up into many small globules like an emulsion of oil. Individual bacteria can be studied, but while they can be violently agitated, we have not yet been able to observe their destruction under the microscope.

If a fine emulsion of oil is examined, an individual

droplet of oil can be singled out and made to rotate rapidly in either direction at speeds that can be accurately controlled by varying slightly the frequency of the oscillating circuit.

An excellent material to illustrate the effects of these waves is a leaf of Elodea, two cell layers in thickness. The protoplasm with suspended chloroplasts forms a thin layer about the cellulose cell wall enclosing the vacuole of cell sap. High frequency sound waves of low intensity passed through these cells cause the protoplasm to rotate very much as in the normal rotation or cyclosis of Elodea. Increasing the supersonic intensity increases the movement until the whole cell is a rapidly whirling mass of protoplasm, fragments of which are torn loose and rotate as small balls in the vacuole. The effect is very striking and might almost lead one to conclude that the normal cyclosis of this plant was caused by high frequency vibrations. The normal protoplasmic rotation of Elodea is stopped by the waves unless they are of very low intensity. Rotation begins again provided the irradiation has not been too strong. Sugar-plasmolysed Elodea cells are affected in the same manner as are the unplasmolysed ones, the whole protoplasm rotating rapidly, until, with increasing intensity, the mass finally bursts and scatters the chloroplasts, still whirling, throughout the cell. Nitella cells when exposed to radiation have the chloroplasts torn from the walls of the cell and whirled rapidly, leaving a clear area which had originally been a uniform green colour.

This stirring of the cell contents is one of the most characteristic effects of supersonics. The smaller the cell, the more difficult it is to stir, but we have observed the rapid rotation of the chloroplasts in moss cells the diameter of which averages 12μ. The phenomenon is not connected with living cells only, but may be observed in Elodea killed by heating or by chloroform, although a greater intensity is necessary since the protoplasm is coagulated on death, and the coagulated mass is only churned with some difficulty.

This microscopic method offers a promising means of attack upon the problem of influencing the development of eggs of various species, as forces can thus be applied inside an egg at different stages of its development without the necessity of puncturing the cell wall or enveloping membrane. The results immediately suggest the interesting possibility of converting an egg with determinate cleavage into an indeterminate one by thoroughly mixing and redistributing the organ-forming substances of its interior. We are now engaged upon this and allied problems, the results of which we expect to publish in due course.

No effects of the waves have been noted that could be clearly traced to an influence on chemical processes in cells, although it is known that high intensity waves influence certain chemical systems, especially metastable ones (W. T. Richards and A. L. Loomis, *Jour. Am. Chem. Soc.*, **49**, 3086; 1927). The phenomena in living organisms, apart from temperature rise, are connected with mechanical effects, the most striking of which might be best described as 'intracellular stirring.'

In certain biological studies where great intensity is desired, and it is not necessary to observe under the microscope, a high-powered oscillator is required.

Using such an oscillator and placing the material to be treated in test tubes which were subjected to the vibrations, Wood and Loomis caused the rupture of filaments of Spirogyra, the tearing of Paramœcium and the laking of red blood corpuscles. This latter effect is very striking, defibrinated mammalian blood corpuscles in physiological salt solution laking completely in one minute before the average temperature of the fluid had risen to 37° C. They also noted the killing of small fish and frogs,

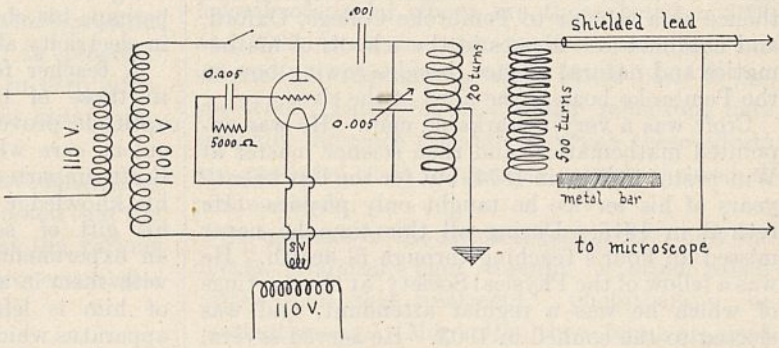

FIG. 1.

but the cause of death was not determined. Using the same high-powered oscillator, we have taken small organisms like Euglena or Paramœcium and enclosed them in capillary tubes sealed at the ends. When one end of such a tube is subjected to intense vibrations the organisms are thrown in piles regularly spaced (about 2 mm. apart, depending on the diameter of the capillary) along the tube, from which they are unable to swim. These piles represent nodes of *transverse* vibrations set up in the capillary. It is not that the organisms swim into these nodes but they are passively carried into the nodes, and fortunately so, for between the nodes they would be subjected to mechanical tearing that would disintegrate them. Thus, red blood corpuscles in a capillary tube are thrown into the nodes and quite unharmed by ten minutes' exposure to radiation, whereas the same corpuscles in a test tube, where convection currents carry them about, are laked in one minute. Even luminous bacteria and particles of gamboge form striæ in capillary tubes, but colloidal particles (as of benzo-purpurin, arsenic sesquisulphide, or ferric hydroxide) do not.

An emulsion of luminous bacteria in sea water in a test tube, exposed to radiation until the

temperature rose from 1·5° to 21·5°, luminesces considerably less brightly than a control tube heated from 1·5° to 21·5°. The turbidity is also less in the irradiated tube, indicating that some of the bacteria have undergone cytolysis. Control experiments showed that the dimming was not due to the electric field. The luminescence of a mixture of Cypridina luciferin and luciferase was unaffected by irradiation in any way that could not be accounted for by rise in temperature.

One might expect that high frequency mechanical vibrations, carrying as much energy as they do, would be capable of stimulating muscle or nerve tissue. All attempts to demonstrate a stimulating action have failed. The sciatic nerve of a frog connected with the gastrocnemius muscle may be touched (either nerve or muscle) to a test tube violently oscillating or be immersed in a salt solution in such a test tube without stimulation and without injury. Both nerve and muscle are later found to be quite irritable to electrical stimuli. The high tension field is unable to stimulate because of its high frequency. A bull frog's heart mounted in Ringer's solution in a test tube touching the oil and connected with a heart lever for recording movement, shows no peculiarities of the contraction, but an irregularity and usually a slowing of the rate, despite the rise in temperature that accompanies the irradiation. Further observations will be necessary to analyse these peculiarities.

Obituary.

MR. W. B. CROFT.

WILLIAM BLEADEN CROFT died at Winchester on Mar. 23 at the age of seventy-six years. Born in 1851, the sixth son of a surgeon, Mr. C. I. Croft, he went to Christ's Hospital, and thence as a scholar to Pembroke College, Oxford, and obtained first classes in the schools of mathematics and natural science, besides rowing bow in the Pembroke boat at the head of the river.

Croft was a very remarkable man. He was appointed mathematical and then science master at Winchester College in 1874, but for the last twenty years of his service he taught only physics. He retired in 1915. During all this time he never missed an hour's teaching through ill-health. He was a fellow of the Physical Society, at the meetings of which he was a regular attendant, and was elected to the council in 1903. He served several times on the committee of Section A of the British Association, and examined for the final honours school in natural science at Oxford.

Croft took little interest in chemistry, but he was a born physicist. Had he been trained in one of the great university schools of to-day, he would have achieved a fame far beyond that which fell to his lot. He had the gift of a vivid scientific curiosity, an uncanny power of pitching upon the first hint of a new discovery before others were fully awake to its importance, and a talent for experiment that almost amounted to genius. He was a constant reader of NATURE and other scientific periodicals, and he carefully cut out articles and pasted them into scrap-books, which he filled with comments and annotations. If anything struck him as likely to lead further, he at once got into touch with the writer of the article or letter, and repeated for himself any experiments that could be compassed in his laboratory, developing them in promising directions. Thus, for example, it came about that he was the first man in England to make a Branly coherer and to perform further experiments with Hertzian waves.

Croft was always at work on phenomena of common occurrence, and never rested until he, and some special pupils, understood its physical significance. Did a question arise about bells or fiddles? Croft set to work immediately upon the fundamentals and harmonics of college bells, and called in the assistance of the musical staff. His photographs of diffraction phenomena were extraordinarily good, and still enrich the pages of Edser's "Light for Students." Light and sound were perhaps his chief interests, but he did good work in electricity also.

A teacher for the few rather than the many, to those of his pupils who by diligence and aptitude proved themselves worthy of the meticulous care which he bestowed upon his lectures, Croft imparted all that they could receive of his knowledge of and reverence for science, and his gift of seeing the essential and planning an experimental approach; and he kept touch with them in after years. A permanent memorial of him is left in the collection of interesting apparatus which he gathered in the College laboratory; but above all, he will be remembered by his pupils, his colleagues, and his many friends for infinite courtesy and thoughtfulness. He leaves a widow, three sons, and a daughter.

WE regret to announce the following deaths:

Prof. Wilhelm von Branca, emeritus professor of geology and palæontology in the University of Berlin, distinguished for his work on the evolutionary history of man and other animals and for work on the development of flight, on Mar. 12, aged eighty-three years.

Prof. Elmer E. F. Creighton, of the General Electric Co., Schenectady, a well-known consulting electrical engineer, on Jan. 13, at the age of forty-nine years.

Mr. Alexander E. Outerbridge, of the William Sellers Company, professor of metallurgy at the Franklin Institute, known for his work on the molecular physics of iron, on Jan. 13, aged seventy-seven years.

Mr. E. A. Reynolds-Ball, author of many travel and guide books, including "Mediterranean Winter Resorts," aged sixty-nine years.

M. Emile Senart, president of the Société Asiatique of Paris and an honorary fellow of the Royal Asiatic Society of Great Britain, and author of "Les Castes dans l'Inde," on Feb. 21, aged eighty years.

Mr. G. Chisholm Williams, a distinguished pioneer in the medical use of X-rays, on April 10, aged sixty-three years.

Supplement to NATURE

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The Physical Basis of Light Therapy.[1]

By Prof. F. Ll. Hopwood.

The Spectrum of Radiation.

THE visible spectrum is only a small portion of the complete spectrum of ethereal waves. Beyond the violet with progressively decreasing wave-lengths, come successively the radiations called 'ultra-violet,' soft X-rays, hard X-rays, the gamma rays of radium, and the very penetrating radiation, the so-called cosmic rays, which have only recently been proved to be of extra-terrestrial origin. Similarly, beyond the red, in progressively increasing wave-lengths, come in turn infra-red and the Hertzian waves used in radio communication.

Table I. gives the approximate wave-lengths of the various radiations, but it must be noted that the divisions are quite arbitrary and that the various regions may overlap; differences in properties arise solely from differences in wave-length.

Table I.

Type of Radiation.	Approximate Range of Wave-lengths.
Hertzian waves . . .	40 kilometres to a few centimetres.
Infra-red	A few millimetres to 7000 A.
Visible spectrum . . .	7000 to 4000 A.
Near ultra-violet . . .	4000 to 3000 A.
Middle ultra-violet . . .	3000 to 2000 A.
Far ultra-violet . . .	2000 to 1000 A.
Soft X-rays	100 to 1 A.
Medium and hard X-rays (used in diagnosis and therapy) . .	0·2 to 0·05 A.
Gamma rays from radium C. .	0·02 to 0·001 A.
Cosmic rays	0·0005 to 0·0003 A.

Note.

1 A. = 1 Angström unit = one hundred-millionth of 1 cm. $= 10^{-8}$ cm.

$1\mu = \frac{1}{1000}$ millimetre

$1\mu\mu = \frac{\mu}{1000} = 10$ A.

Light used in Therapy.

Both natural and artificial sources of light are used for therapeutic purposes, and considerable differences of opinion exist as to their relative merits. These differences arise very largely from the fact that the relative distribution of energy amongst the infra-red, visible, and ultra-violet portions of the spectra of the different sources varies over wide limits.

Numerous observers have noted the close parallelism between pigmentation due to exposure to light and beneficial therapeutic results. Experiment has shown that the solar radiations which are most active in producing pigmentation of the skin and hæmobactericidal effects are those between 2900 and 3000 A., or, in other words, those which are situated in the middle ultra-violet part of the spectrum. Infra-red and visible radiations may certainly influence the rate at which these effects are produced, but in general cannot themselves produce them.

On account of the spectral region used and the effects produced, light therapy is often called 'ultra-violet light treatment,' 'phototherapy,' or 'actinotherapy.' More often these terms are used in connexion with artificial sources of light to distinguish such treatment from 'heliotherapy,' or sunlight treatment.

Sunlight.

The natural source of ultra-violet radiation is the sun. The spectrum of sunlight after filtration by the earth's atmosphere extends continuously from the infra-red to the middle ultra-violet regions (30,000 to 2900 A.), but its limits are influenced by the seasons, height of the sun above the horizon, altitude of the place of observation, water vapour content of atmosphere and atmospheric pollution. The lower the sun is in the heavens, the greater is the length of path through the earth's atmosphere that its radiations have to traverse, and the resulting absorption considerably shortens the range of the spectrum. The intensity of its ultra-violet radiation reaches its maximum about one hour after midday on a clear day. Dull, cloudy weather, coupled with atmospheric pollution due to smoke and chemical fumes, may practically reduce to zero the intensity of these active rays in the neighbourhood of a large city.

It is important to note that the total ultra-

[1] Reprinted, after revision and with additions, from *St. Bartholomew's Hospital Reports*, 1926.

violet radiation from the sky is more than that from the direct sun. Even with the sun at its zenith the ultra-violet radiation from it does not exceed 90 per cent. of that from the blue sky, whilst with a low sun the sky yields far more. This addition to the amount of ultra-violet radiation which a patient receives from the direct sun is due to the scattering of the sunlight by the smallest particles of the atmosphere. The effect is the more pronounced the shorter the wave-lengths involved. As Rayleigh has shown, the amount of energy scattered by a particle of given size varies inversely as the fourth power of the wave-length, and consequently the phenomenon exhibits itself more in the ultra-violet than in the visible spectrum. Thus — a fact of great practical importance—it is not essential to be exposed to the direct sun in order to receive the benefits of heliotherapy.

The above considerations show us that treatment by natural sunlight (heliotherapy) is intimately associated with geographical and climatic conditions. In the Alps, at altitudes of above 5000 ft., pure, fresh, dry air and an almost constant daily supply of sunlight are easily obtainable, whereas in England the sun appears only erratically, and its ultra-violet component varies rapidly within wide limits, rendering dosage difficult and regular treatments impossible. For these reasons, artificial sources of radiation have been developed by which constancy of output can be strictly controlled.

Artificial Sources of Ultra-violet Radiation.

All the artificial sources of light used for therapeutic purposes are heterochromatic (that is, emit a broad band of wave-lengths), since, up to the present, no one has designed a practicable source of monochromatic radiation of sufficient intensity to be of definite therapeutic value.

The chief sources of ultra-violet radiation are electric arcs. Incandescent electric lamps with their bulbs made of fused quartz or of glass manufactured for its special transparency in this region of the spectrum (such as vita-glass) are occasionally used for some purposes, but their low energy output makes their general use impracticable.

The arc-lamps usually employed are of two types, namely, (*a*) open arcs, and (*b*) enclosed arcs.

(*a*) Open arcs have electrodes of iron, tungsten, metallic alloys, or carbon. Carbon electrodes may be either solid, 'neutral cored,' or 'impregnated.' Neutral cored carbon electrodes have a soft core of carbon powder mixed with a small amount of some substance such as potassium silicate to ensure quiet, steady burning. Impregnated carbon electrodes have mixed with the carbon powder, either salts of various metals, powdered metals, or a central wire core. Thus 'white flame' carbon electrodes usually contain the fluorides of the rare earths obtained as residues from monazite sand; 'blue flame' carbons contain iron. The ultra-violet radiation emitted by these arcs varies greatly with the chemical composition of the electrodes and the current between them. A high current density is necessary for high efficiency.

(*b*) Enclosed arcs are mercury vapour lamps with fused quartz (not glass) envelopes.

All these lamps produce ultra-violet radiation of sufficient intensity and satisfactory quality for therapy. Each differs from the rest in spectral range and has its special advantages and defects.

One of the varieties of carbon arc is usually employed in institutions when group treatment is given, and a mercury vapour lamp for individual or localised treatment. The order of the maximum relative percentage of ultra-violet radiation of wave-lengths less than 3200 A. in the total radiation emitted by the above sources, is

Mercury arc.
Impregnated carbon arc.
The sun.
Neutral cored carbon arc.
Incandescent electric lamp.

The radiation from the neutral cored, or solid electrode carbon arc is similar to that of the sun, in that it is relatively weak in radiation of wave-lengths less than 2900 A. It is, however, strong in infra-red radiation of wave-lengths longer than 30,000 A., which the earth's atmosphere has eliminated from the solar rays.

Special dispositions are required to maintain metallic arcs on an alternating current supply.

We know that radiations from the middle ultra-violet region can exert marked bactericidal properties *in vitro*, and also 'activate' certain substances such as ergosterol, etc., in such a manner that when ingested they tend to cure rickets. We also know that the bactericidal power of the blood is enhanced, and the mineral metabolism promoted, when the living animal is subjected to these rays. Some effects, such as the erythema following irradiation, only appear after an interval of time—called the 'latent period'—has elapsed since the exposure terminated. How these effects are produced is not known with certainty, and light therapy is still mainly empirical.

Photo-electricity.

For every substance there are radiations which will cause some of its atoms to eject electrons and consequently leave the stripped atoms positively charged. This phenomenon is called ionisation or photo-electric emission. For it to occur, it is only necessary that the wave-length of the incident radiation should be less than a critical or threshold value, which is characteristic of the atom ionised. For most substances the critical wave-length lies in the ultra-violet spectral region, but for some it occurs in the visible spectrum, and for cæsium is actually in the infra-red region (see Table II.). The wave-length which will cause maximum emission of electrons from any element is approximately two-thirds of the critical wave-length for that element, and for sodium, potassium, and cæsium lies in the visible spectrum. The velocity of emission of photo-electrons depends on the wave-length of the exciting light, whilst the number emitted depends upon the intensity of the light.

Table II.

Element.	Critical Wave-length in A. for Photo-electric Effect.
Graphite	2615
Copper	2665
Selenium	2670
Iron	2870
Cadmium	3130
Zinc	3425
Sodium	6000 (about)
Potassium	7000 ,,
Cæsium	8000 ,,

As the emission of photo-electrons from an illuminated surface is very susceptible to the presence of condensed surface films of gas or vapour, it is necessary for reproduction of photo-electric effects that the surfaces be prepared, and maintained, in high vacua.

Fluorescence and Phosphorescence.

Certain substances, when stimulated by radiation of one wave-length, emit radiation of a different wave-length. If the emission only appears whilst the stimulus is being applied the phenomenon is called fluorescence, but if it persists after the stimulus has ceased it is called phosphorescence.

Phosphorescence is only exhibited by solids: fluorescence by solids, liquids, and gases. Although Stokes stated that fluorescent light was always of longer wave-length than the exciting light, we now know that this rule, though generally valid, is not invariable.

Fluorescence is caused by the return to a more stable position in an atom, of electrons displaced by the exciting radiation.

Photo-chemical Action.

That chemical action can be brought about by light has been known for a very long time, and is familiar to everyone through photography. Photo-chemical actions are usually divided into three classes, namely:

(*a*) Photo-catalytic actions in which light only accelerates an irreversible process. Here the light cannot be regarded as stored up in the transformed substance as chemical energy. The action only occurs in the presence of a catalyst. Thus, in the presence of colloidal uranium, formaldehyde may be synthesised from carbon dioxide and water, by exposure to sunlight. Without the uranium no formaldehyde is formed.

(*b*) True photo-chemical equilibria in which the equilibrium of some reversible reactions is altered by light, and again brought back to the initial state on standing in the dark. (Compare the behaviour of a selenium cell which conducts electricity better when illuminated than in the dark.)

(*c*) False chemical equilibria, which are irreversible processes composed of two or more photo-catalytic reactions.

In certain cases the initial action of radiation is to decompose some substance (called a 'negative catalyst') which hinders the chemical action which takes place some time after the irradiation of the system has proceeded (cf. erythema and pigmentation).

Photo-chemical actions are subject to the following two laws:

Grotthus's Law.—Radiation must be absorbed in order to bring about the reactions which it produces.

Bunsen-Roscoe Law.—The amount of substance decomposed by radiant energy is proportional to the amount of radiant energy absorbed—that is, is proportional to the product of the intensity of the radiation, by the time for which it is applied.

In connexion with the above, it should be noted that radiations of different wave-lengths may produce different actions on one and the same substance. It appears to be a fairly general rule that of two radiations which produce opposite effects, it is the longer wave-length which produces the oxidising action and the shorter wave-length the reducing action. The decoloration, by infra-red rays, of glass which has been coloured by ultra-violet rays, illustrates this.

Several writers have claimed that they have detected a similar opposing action, or physiological interference, of infra-red and ultra-violet radiations in the production of erythema of the skin, or the

immobilising action on bacteria *in vitro*. These observations, which have not yet been confirmed beyond doubt, are of great interest from the point of view of choice of an artificial source of radiation and the measurement of dose.

Unlike most chemical reactions, in which rise of temperature produces a marked increase in the velocity of reaction, the effect of temperature on photo-chemical reactions is usually very small.

Absorption, Transmission, and Reflection.

Certain substances strongly absorb light corresponding to some parts of the spectrum, and transmit the remaining light unchanged. This phenomenon is called selective absorption. It produces dark bands, called absorption bands, in the spectrum of the transmitted light.

Absorption bands are characteristic of the absorbing substances and serve to identify them by examination with a spectroscope, for example, the bands of hæmoglobin and chlorophyll.

By making use of the selective absorption bands of different substances, it is possible to make light filters which will transmit narrow bands of wave-lengths in chosen parts of the spectrum.

The reflecting, transmitting, and absorbing powers of a substance for light in the visible spectrum give no trustworthy indication of these properties for radiations in the infra-red or ultra-violet regions.

The percentage penetration of *dead* human skin by ultra-violet radiation is given in Table III., which records some measurements by Hasselbalch.

Table III.

Thickness of dead skin in mm.	Wave-length in A.						
	4360.	4050.	3660.	3130	3020.	2970.	2890.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
0·1	59	55	49	30	8	2	0·01
0·5	7·0	5·0	3·0	0·3	—	—	—
1·0	0·5	0·3	0·08	0·006	—	—	—

The practically negligible penetrative power of the biologically active ultra-violet rays indicated by this table is very marked. Definite clinical evidence is available, however, which shows that ultra-violet radiation of wave-lengths shorter than 2900 A. can produce marked physiological effects. The difficulty of explaining these effects by any direct or indirect action has recently been considerably lessened by the work of Macht and his co-workers. These investigators have shown that the penetration of ultra-violet radiation into *living* tissue is greater than for dead tissue. This is brought out by comparing the figures in Table III. with those published by Macht and summarised in Table IV.

Table IV.

(Transmission of monochromatic ultra-violet radiation through living animal tissue, 1·175 mm. thick.)

Wave-length in A.	4050	3660	3130	3025	2800	2650	2537
Transmission (per cent.)	16·3	11·4	19·5	27·2	56·3	23·8	42·8

Infra-red and luminous rays can penetrate more deeply than ultra-violet rays. Sonne has shown that the luminous rays can produce a greater elevation of temperature below the skin than the infra-red rays, and asserts that this heating effect due to absorbed luminous rays assists in the destruction of toxins and formation of antibodies.

Ordinary window glass transmits a portion of the ultra-violet nearest the visible region of the spectrum, but cuts out completely all wave-lengths less than 3100 A. It thus absorbs all the solar radiation which produces pigmentation, etc. Fused quartz and water transmit ultra-violet radiation quite freely down to wave-lengths of about 2000 A. Corning glass 980 A. transmits all solar radiation almost as freely as the more expensive fused quartz. Vita-glass resembles Corning glass 980 A. in its properties, but is not so transparent for equal thicknesses, and also exhibits some deterioration in transmission after exposure to sunlight.

'Wood's' glass, which cuts out most of the visible spectrum, transmits a band of wave-lengths in the near ultra-violet region about 3600 A. and is therefore useful for fluorescence experiments.

Snow is a good reflector of ultra-violet radiation, and snow-blindness is due to the reflection by it of the short waves of sunlight.

Polished surfaces of magnalium, nickel, and aluminium make the best reflectors of the middle ultra-violet region of the spectrum for ordinary purposes; silvered mirrors are much poorer.

The biological effect produced by uninterrupted exposure to ultra-violet radiation appears to be directly connected with, and in proportion to, the energy absorbed (Bunsen-Roscoe Law). The intensity of the incident radiation and the time of exposure are the external quantities, and the absorption coefficient of the skin the internal quantity, which determine the quantity of energy absorbed, and therefore the biological effect.

It has already been pointed out that all sources of radiation used in light therapy are heterochromatic, and that radiation from them is absorbed differentially by the skin. Reference has also been made to

Sonne's assertion concerning the effects of luminous rays, and also to the possibility of antagonistic action between infra-red and ultra-violet rays. Throughout this article it has been assumed that exposure to *ultra-violet* radiation is essential for the production of the recognised benefits of light treatment. This assumption seems to be perfectly in agreement with experience. What is not yet satisfactorily settled is whether (and if so, what) other wave-lengths are also useful or harmful.

It is this lack of knowledge which renders the physical measurement of the therapeutic efficiency of an arc-lamp uncertain.

Determination of Quality.

The quality of the radiation emitted by a given source may be determined by passing the radiation through a spectroscope and examining the emergent beam. As glass absorbs both infra-red and the middle and far ultra-violet rays, it cannot be used for this work, and therefore the prisms and lenses used are of quartz or rock-salt.

For the visible and ultra-violet regions down to wave-lengths less than 2000 A., this examination may be done by direct observation, the rays in the ultra-violet being detected by the visible fluorescence caused either in uranium glass or in a smear of vaseline. Alternatively, these regions may be recorded on a photographic plate. For the infra-red spectrum we must use one of the methods mentioned later. When examined by any of the above methods, it will be found that whereas the spectra of tungsten and mercury consist mainly of bright lines, that of pure carbon is practically a continuous one, being similar in character to the solar spectrum. From the known constants of the apparatus, or by making use of reference lines of known wave-lengths, it is possible to determine the range of wave-lengths in a spectrum and the wave-lengths of any bright lines in it.

Determination of Intensity.

In determining the intensity of radiation proceeding from a source and falling on a surface, we have to decide which of the following three quantities we wish to measure :

1. The total intensity.
2. The intensity of a group of radiations of differing wave-lengths.
3. The intensity of the radiation of a single wave-length.

In measuring the total intensity, no preliminary analysis of the radiation is required. To measure the intensity of a group of radiations, either colour filters must be used to isolate it, or some instrument employed which is only sensitive to radiations in the given region.

For the measurement of the intensity of the radiation of a single wave-length, the total radiation is first resolved by means of a spectroscope and the particular radiation caused to pass through a narrow slit to the measuring instrument.

Whichever of the three intensity measurements is to be made, the following methods are available : (*a*) Thermal, (*b*) fluorescent, (*c*) chemical, (*d*) electrical.

Thermal Methods.

Either a thermopile or bolometer may be used.

The thermopile consists of a number of thermocouples or pairs of electrical conductors of different metals, and is used joined in series with a galvanometer. Whenever one junction of a thermocouple has its temperature raised above that of the other, an electric current will flow through the galvanometer. By allowing the radiation to fall on the junctions of a thermopile which have been covered with lamp-black and by using a sensitive galvanometer, measurements may be made over the complete range of wave-lengths used in light therapy.

The bolometer consists essentially of a blackened fine metallic wire the rise in temperature of which, when radiation falls upon it, alters its electrical resistance. This change in resistance, when measured by suitable means, gives the intensity of the absorbed radiation. The sensitiveness of both thermocouples and bolometers is increased by mounting them in evacuated vessels to reduce the cooling effect of the surrounding gas.

Fluorescent Methods.

In practice these methods are only applicable to measurements made in the ultra-violet region. They depend upon the fact that the intensity of the fluorescent light emitted by such substances as barium-platino-cyanide and zinc sulphide is directly proportional to the intensity of the exciting radiation.

Chemical Methods.

A great variety of photo-chemical reactions have been proposed and used for measuring either total or ultra-violet radiation. The effect most frequently used is the reduction of silver chloride as in photography. Here, instead of weighing the silver liberated, the resulting blackening is used as a measure of intensity, either by finding the time necessary to produce a standard blackening, or the blackening produced in a definite time.

Leonard Hill has devised a system of measure-

ment of the ultra-violet radiation of wave-lengths shorter than about 3600 A. by making use of their bleaching effect on a solution of methylene blue in acetone.

The standard solution is exposed in a quartz tube and the 'exposure' measured by comparing its tint with some standard tints calibrated in terms of the lethal effect on infusoria. The scale adopted is quite an arbitrary one.

Janet Clark has suggested using the blackening effect of ultra-violet radiation on lithopone (a pigment containing zinc oxide, zinc sulphide, and barium sulphate) for intensity measurements. This substance, when moistened with water, darkens under the influence of rays of wave-lengths less than 3200 A. It thus appears to afford a simple colorimetric method of measuring those rays which can produce an erythema of the skin.

Electrical Methods.

These generally make use either of the photo-electric property of some metal—generally zinc or cadmium—or the fall in electrical resistance of selenium when illuminated. A glance at Table II. will show what metal is best suited to the particular radiation to be measured. In principle, a photo-electric cell consists of an insulated plate of metal connected to an electrometer or gold-leaf electroscope, the system being negatively charged. Under the influence of a suitable radiation, the plate loses its charge at a rate dependent upon the intensity of the radiation.

The action of a 'selenium cell' is somewhat different. As ordinarily used, the change of resistance of the cell when illuminated is measured by the change in current through a microammeter connected in series with the cell and an energising battery. This effect can be produced by infra-red, visible, ultra-violet, Röntgen, and gamma radiations, and is not the normal photo-electric effect.

It is easily seen that any of the instruments described above can readily be used to give a trustworthy check on the emission of a given source at different times. Their value in comparing the different emissions of different sources is not quite so certain.

Inverse Square Law.

The intensity of the radiation falling on a surface can only be assumed to diminish according to the law of inverse squares (1) when the active dimensions of the source are small compared with its distance from the surface, and in addition (2) when no reflector is used.

Dangers and Precautions.

Three common sources of danger in connexion with the use of artificial sources of ultra-violet radiation, and the precautions necessary to avoid them, are :

(1) The production of a severe conjunctivitis, through looking directly at an arc. Operators and patients should always wear protective goggles or shades.

(2) Over-exposure through continuing a course of treatment after replacing an old mercury vapour arc-lamp by a new one, or substituting different electrodes in an open arc. An intensity measurement should always be made when using a new source.

(3) Electric shock through touching 'live' electrical conductors. Several fatalities have occurred through the use of electrical apparatus in bath-rooms, where the conditions for short circuiting the supply through the body are almost ideal.

No installation should be set up in such a position that a patient can touch a 'live' electrode and a water-pipe or 'earthed' conductor at the same time. It is advisable to use a floor covering of linoleum or carpet.

Contra-Indications to Light Therapy.

In addition to the purely physical dangers mentioned in the last paragraph, there are many physiological and pathological conditions—such as menstruation in women, low blood pressure, fever, hyper-photo-sensitiveness, etc.—which are contra-indications to the therapeutic use of ultra-violet radiation. The discussion of these lies outside the scope of the present article.

Biological Action of Ultra-Violet Rays.

By Prof. Leonard Hill, M.B., F.R.S.

RADIATIONS from sources of energy—sun, stars, etc.—are conducted by waves in a hypothetical ether with a velocity of 186,000 miles per second in the case of light. Ether radiations include the Hertzian waves used in radio with wave-lengths extending to a thousand metres or more, then the infra-red, with wave-lengths from 60,000 to 700 $\mu\mu$, then the visible with wave-lengths from 700 $\mu\mu$ (red) to 400 $\mu\mu$ (violet). Beyond the visible lie the invisible ultra-violet rays with wave-lengths from 400 $\mu\mu$ to 100 $\mu\mu$, and beyond these come the soft X-rays and

then the hard X-rays and the rays of radium with wave-lengths so short as 0·01 $\mu\mu$.

The body of a man is screened by the horny layer of the epidermis, varying in places from some 0·02 to 0·5 mm. thick, beneath which lie the living cells of the epidermis in layers of corresponding thickness to the thin horny layer. These cells are myriad in number, and are naturally exposed to the influence of light in wild naked men. Beneath these comes the derma or true skin, in which circulates the blood through close woven networks of capillaries, in streams some 0·01 mm. thick. Among the living cells of the epidermis and in the derma are nerve endings. The epidermis reflects and scatters a part of the rays which fall upon it, but some of the visible rays penetrate and are absorbed by the blood beneath, warming this. The infra-red rays, on the other hand, are absorbed by the least layer of water; caught therefore by the wet layer of the epidermis, they warm this and warm the blood in the derma indirectly by conduction. The biologically active or middle ultra-violet rays are also very largely absorbed by the epidermis, and exert their effect there. The shorter ultra-violet rays, powerful to kill microbes, fail to penetrate the horny layer and so have no action on the skin. The longer ultra-violet rays, like the visible rays, reach the blood in the capillaries of the derma and are converted into heat.

The skin screens itself from excessive light by its horny layer and by pigment. The horny layer is thickened by ultra-violet rays killing the living cells of the epidermis, and protection is thus quickly afforded from sun burning. Pigment lying in the deeper cells of the epidermis, by absorbing visible and ultra-violet rays, screens these deeper cells and the blood in the derma. It converts visible rays into heat, and this heat, stimulating the nerve endings in the skin, may reflexly lessen body heat production while increasing body heat loss by provoking sweating and dilatation of cutaneous blood-vessels. Increased transpiration of water is the chief method of warding off excessive radiant heat when shade is not available. The increase of heat and transpiration by the visible rays is important in the treatment of wounds, etc.

The sterilising power of the ultra-violet rays, first established by Downes and Blunt (1877), is not nearly so important as has been thought, for the rays can only kill the surface bacteria; they cannot penetrate into filth any more than through the epidermis. Tubercle bacilli rotated in serum in a quartz flask under a mercury vapour lamp are not killed, so great is the protection afforded by the proteins of the serum which absorbs the ultra-violet rays (Eidinow). In the case of tissues or infusoria screened by mesentery, there is a partial, by the skin complete, protection from the lethal action of ultra-violet rays. The penetration of the biologically active ultra-violet rays is not more than 0·25 mm. in an organ exposed to the mercury vapour lamp for an hour or two, as is demonstrated by the depth of the lesion thereby produced.

The intensity of illumination received from a point source of light is inversely proportional to the square of the distance from the source. The law is only accurate from a source sufficiently small or far enough off to be treated as a point. It does not hold for sources with reflectors behind or lenses in front of them. Only these rays which are absorbed exert an effect. When light passes through a layer of absorbing substance, the fraction transmitted depends on the nature and thickness of the substance and the wave-length; the transmission coefficient is the fraction transmitted by a layer 1 cm. thick.

If light passes two absorbing layers successively, the final fraction transmitted can be calculated by multiplying together the fraction transmitted by each layer alone. Thus, if each layer transmits 1/10th, two in succession transmit 1/100th. Epidermis 0·1 mm. thick transmits about 1/10th, and therefore epidermis 0·2 mm. thick transmits only 1/100th of the amount of active ultra-violet rays.

The biologically active region of the ultra-violet rays is round about 300 $\mu\mu$. Hausser and Vahle, using equal energy values, found the maximal erythema effect at 297 $\mu\mu$. Four per cent. of this effect was found at 313 $\mu\mu$ and 16 per cent. at 256 $\mu\mu$. The longer ultra-violet rays are little absorbed by the epidermis, and so have little action; the shorter ones are very active, but are absorbed by the horny layer of the epidermis and so do not reach the living cells. Owing to the absorption by the horny layer of the epidermis and its screening action, the living cells beneath are protected from the short ultra-violet rays of artificial sources which penetrate into and are most powerful in killing microbes, infusoria, and ciliated cells of the wind-pipe. The ultra-violet rays of the sun extend scarcely beyond 300 $\mu\mu$, and the sun exerts its sun-burning action by ultra-violet rays longer than those of artificial sources such as the long flame metal cored carbon arc or mercury vapour lamp, the active rays of which are mostly of wave-length shorter than 300 $\mu\mu$. Vita-glass lets 75 per cent. of the active ultra-violet rays of the sun

through, but largely reduces the active rays of the mercury vapour lamp, so that the lethal exposure for infusoria is made much longer when this screen is interposed. The rays which activate ergosterol and form vitamin D are in the region of about 280-300 $\mu\mu$; it is, then, clear skies and high sunlight, which afford rays about 300 $\mu\mu$, having this effect.

Mist, smoke-pollution, glass windows, walls and roofs, and clothes, cut out the sunlight and deprive us of the effect which the sun naturally exerts on naked wild men and animals, for example, on ergosterol, which, eaten in the food, is present in the skin, and there awaits activation into vitamin D by sunlight. It must be borne in mind that the bright sky shine is a source of ultra-violet rays, affording more (from the whole sky) than the high sun affords directly. Owing to this fact, cool ultra-violet treatment can be had from the sky without exposing febrile patients to the direct hot sun. Skyshine and earlier morning sun can be used by febrile cases of tuberculosis. To heat such patients is a disadvantage, hence the excellence of the alpine climate. Exposure to cold air stimulates the tone of the muscles and the appetite, and works, under proper control, as much good on the naked body as light does.

Rickety, weakly children kept in an open-air shed without artificial heat throughout the winter do wonderfully well, and become robust and full of life and energy. The clean cool air, absence of crowd-infection, and indoor dust, heat, and noise, work their good effects as well as light. It must always be borne in mind that the open cool air is at least as important as light in treatment of tuberculosis, wounds, etc.

We can take in vitamin D from cod-liver oil, or nowadays eat it in tabloids, the product of laboratory irradiation of ergosterol.

Not only rickets, but also osteomalacia, prevalent in the purdah women of Kashmir (Vaughan), is due to want of sunlight and vitamin D. With rickets go decay of teeth, liability to catarrhal and low infections. Open-air treatment and ultra-violet irradiation are powerful to prevent these troubles. In fowls kept under glass, ultra-violet irradiation improves the egg laying and hatching, and prevents leg weakness of chicks. Similarly, it improves the stamina and milk of cows kept in byres.

In the treatment of surgical tuberculosis and wounds, carbon arcs have advantages in yielding abundantly visible and infra-red rays as well as the ultra-violet rays. The mercury vapour lamp is relatively a cold source, but incandescent lamps can be added to it so as to make good the deficiency. The monkeys, iguana lizards, and tortoises at the Zoo do well under incandescent lamps. The monkeys are also given access to open air. The conversion of visible light into blood heat is most important to all these animals. The lizards, heated up by the visible rays of the lamps, become active, hot-blooded animals as they naturally do by day under the tropical sun. Babies exposed naked under incandescent lamps and given also exposure to cool open air, would thrive as well as the monkeys do, the diet chosen being of course one fully provided with the necessary vitamins, and those other qualities required for growth and health.

The ultra-violet rays reaching the living cells of the skin and absorbed therein, cause change in atomic structure (displacement of electrons from their orbits with consequent rearrangement of molecules), which result in chemical changes ending in coagulation and death. The increasing granulation of the protoplasm of infusoria can be observed under the microscope when these animals are exposed in a water-cooled quartz chamber to the mercury vapour lamp. The same sort of change is produced whether longer or shorter wave-lengths of the active region of ultra-violet rays are used to kill. There is no evidence of specific changes set up by one or other of the different wave-lengths absorbed by the skin, other than possibly in the case of activation of ergosterol. There is no evidence that one group of the active ultra-violet rays is more or less harmful to living cells than another; the result depends on penetration and absorption. Given a sufficient dose of rays absorbed, coagulation and death takes place. The damage of the living cells in the skin produced by sunburn provokes secondarily a local hyperæmia, œdema, and leucocytosis, followed by desquamation and pigmentation. The inflammatory reaction increases the power of the blood to kill staphylococci as tested *in vitro*. In some way, as yet unexplained, it provokes better feeling of health and vigour, but overdosage may have the opposite effect. The inflammatory reaction helps the skin to recover from infections such as lupus. This terrible disease is cured by local and general light baths. Surgical tuberculosis is benefited by light and open air.

The ultra-violet rays can be used successfully for certain affections of the eye as well as skin, but all this is the province of the medical practitioner skilled in such treatment. By the general public light baths should only be used in mild doses for taking the place of natural sunlight. The body

can conveniently be divided into four parts: 1, front of body; 2, back of body; 3, front of legs; 4, back of legs. One part is bathed at a time. Two baths a week suffice. Using a long flamed arc with iron-cored carbons or a mercury vapour lamp, a 5-minutes' exposure, 2 ft. away, suffices. Large doses result in a thickened horny layer and pigmentation which prevents the reaction of the skin. It may be as well to intermit the light bath for a month at the end of two months, and then start again. If a vita-glass screen is used, the artificial sources are made more to resemble sunlight and much safer to use. Overdosage can do more harm than good.

The Physiological Action of Ultra-Violet Radiation and its Use in the Home.

By W. Kerr Russell, M.D., B.S. (Dunelm).

THE founder of the science of actinotherapy was Finsen, and he published his first paper on the subject of ultra-violet radiation in 1893. His efforts were directed to the cure of lupus (the wolf), that disfiguring disease of the skin caused by the tubercle bacillus, a disease which so often causes those attacked by it to hide themselves away in order to avoid the gaze of their fellows. This new local form of treatment devised by Finsen was a wonderful success, and it was only Finsen's early death, at the age of forty-three years, that prevented him from carrying out other most important applications of the treatment. He left at his death the complete designs for a clinic in which investigations were to be undertaken for the purpose of ascertaining more exactly what affections would lend themselves to treatment by general light baths, and among the diseases in which this treatment was to be used, he expressly mentioned tuberculosis.

Describing his proposed carbon arc bath, Finsen said it consisted of a circular room in the middle of which were two gigantic arc lights of 100 amperes, suspended about six feet from the floor; by numerous radiating partitions, bath chambers were arranged in which the patients could lie naked on couches. It was, however, only after a visit to Switzerland, where Reyn, Finsen's brother-in-law, saw the successful work of Bernhard and Rollier in the cure of extra-pulmonary tuberculosis by regulated exposure to the sun's rays, that he instituted the general light bath treatment at the Finsen Institute in 1913. Then came the War, and though it is true that hundreds of thousands of wounded men were treated by physiotherapy, and that the conflict was largely responsible for bringing physical methods of treatment into prominence, it has only been during the last few years that general ultra-violet treatment has received the recognition in Great Britain which it deserves.

Actinotherapy is still in its infancy, and a great deal of research work is necessary before the reproach of empiricism can be removed. This makes it imperative that it should only be employed with great care and discrimination. One must also remember the cruel fate which has overtaken so many of the pioneers of X-rays, and though, judging by the experience of the Finsen Institute, it is very improbable that a similar catastrophe will befall the actinotherapist, the need for the exhibition of great caution is obvious. Dosage is a very important factor in all forms of medical treatment; we make use of the beneficial action of heat when we apply a poultice to relieve the pain of inflammation, but in excess, those same heat rays can act destructively and cause a painful burn. This is the case with X-rays, where ulceration and even cancer can be caused. Ultra-violet rays, too, are harmful in excess; the same applies to drugs, most of which, given in too great doses, can act as dangerous poisons.

It is obvious that the prevention and cure of disease should principally be the concern of those who have been specially qualified by suitable training to perform this important work. Therefore, the only persons at the present moment who should undertake ultra-violet treatment are members of the medical profession. Unfortunately, anyone can at the present time administer ultra-violet or X-ray treatment to others. It is no longer fashionable for the quack to sell pills in the market-place; he much more probably nowadays administers physical treatment in some fashionable part of the town. It has been said that there is no part of medicine which is so nearly allied to quackery as is physical treatment, and this stricture will last so long as the present chaotic state of affairs is allowed to continue. The quack, with his power to issue blatant advertisements, will continue in his present affluent state, indiscriminately maltreating suffering humanity. It all reminds one strongly of a character in Shaw's sparkling play, "The Doctor's Dilemma," whose procedure was to give his advice free, the fee for the course of treatment to be paid in advance, and cure guaranteed. A correct diagnosis is the essential

factor in the satisfactory treatment of any form of disease.

Recently, owing to the ill-advised propaganda of certain manufacturing firms and individuals who have allowed their commercial zeal to outrun their discretion, the tendency has been rather for lay interest to exceed medical in regard to ultra-violet radiation.

There are two ways in which the ultra-violet rays can be utilised for curative purposes—exposure of the body to the sun's rays, or irradiation with an ultra-violet lamp. Ultra-violet treatment can be general, local, or internal, and in the writer's opinion the only form of ultra-violet treatment which should be used at home is general treatment, that is, exposure of the whole body to the rays.

In regard to the most suitable form of ultra-violet lamp for use in the home, the obvious choice is the carbon arc. The extreme power of the quartz mercury vapour lamp, which renders it a most valuable instrument in the doctor's hands, is a source of real danger when it is used in the home, and for the same reason, the home use of the tungsten arc with its short erythema-producing dose is also undesirable. Mercury vapour lamps can, however, be purchased where either the burner is made of translucent quartz, or a screen of the same material, or of vita-glass, is placed in front of the burner; in both these cases the time of exposure is greatly lengthened, and the risks of over-dosage considerably minimised, so that no objection can be taken to the home use of lamps of this kind.

The disadvantages of the carbon arc are the initial cost of a trustworthy model with automatic regulation, and the cost of the electric current necessary for the proper functioning of the lamp, which is considerable. Incidentally, several persons can be treated with one carbon arc lamp simultaneously, so that it seems that one solution of the difficulty is the formation of special clinics where ultra-violet treatment can be administered collectively at a reasonable charge under medical supervision. Special physical treatment clinics are increasing daily, especially in Germany, where there are many excellent establishments for the treatment of rheumatic disorders. However, the careful home use of ultra-violet radiation is justified by intelligent persons in good health who wish to make use of its tonic effects, but the treatment of disease is an entirely different matter, and the great temptation of a layman who has installed a lamp to treat various ailing friends and neighbours, should be firmly resisted. A doctor's advice and supervision are imperative in the treatment of disease.

The dangers of unskilled radiation treatment are very real, and many fatal cases of exfoliative dermatitis have occurred. A few years ago an accident took place in which a patient, who had been in the habit of giving himself ultra-violet treatment with a quartz mercury vapour lamp at home, while lying on his bed, fell asleep. Instead of his usual ten minutes' exposure, he was irradiated for one hour and ten minutes. Marked reddening of the skin occurred and peeling followed. Twelve days later, a general redness of the skin developed, and at the end of another five days, the heart became gravely affected and very irregular; the patient was seriously ill for four days and then gradually he began to improve. Meanwhile the peeling of the skin continued, and after the lapse of a further two weeks, a hæmorrhagic rash appeared all over the body, and afterwards the patient slowly recovered. A short while ago an acquaintance of the writer's bought a mercury vapour lamp, and his first irradiation was so ill-timed that a marked erythema developed, and as a consequence the expensive lamp was promptly laid aside.

Though the ultra-violet rays have very little power of penetrating the skin, they are nevertheless able to produce two striking peripheral effects, namely, erythema or reddening of the skin, and tanning, or pigmentation. Actinic erythema, unlike that produced by the infra-red rays, comes on after a latent period of four to twelve hours, and pigmentation follows the erythema. It must be remarked that the skin exercises an important protective function against excessive irradiation; it is also an insulating medium, an excretory and an endocrine organ, and it contains many arterioles, and is the most extensive sensory organ of the body.

There are many theories regarding the action of the ultra-violet rays. One is that some of the rays penetrate to the capillaries in the vascular layer of the skin, where they are absorbed by the blood and chemical changes occur, leading to a general body effect. Another theory is that the rays have a direct photo-electric effect on the nerve endings in the skin, and yet another that the rays act photo-chemically on the skin fat-producing vitamin D, the bone-forming vitamin. Probably all three theories are partly true. An important action of ultra-violet rays is their power of killing bacteria. Five seconds' exposure to the rays from a mercury vapour lamp is often sufficient to kill some virulent organism. Water, which is probably the most transparent liquid to the ultra-violet rays

that we know, can be sterilised readily by them. The sun is Nature's universal disinfectant, and it is only in darkness that the organisms which are harmful to man and other animals can flourish.

Irradiation of the body generally leads to a fall in blood pressure, and Finsen proved that there was a seasonal variation in the numbers of red blood corpuscles, the number being greatest at the end of summer and least at the beginning of spring. So that if the red blood corpuscles are reduced in number, they generally increase after exposure to the ultra-violet rays. The hæmoglobin colouring matter of the red cells also increases in amount, and this proves an analogy with plants which, when grown in darkness, are deficient in chlorophyll. Changes occur also in the white blood corpuscles; the polymorphonuclear cells decrease, and the lymphocytes and, most markedly of all, the eosinophilic cells, become more numerous. There are alterations in the blood serum, and if there is an excessive quantity of blood sugar present, it is reduced. The amount of tyrosin in the blood serum increases, but decreases when pigmentation occurs, and a basic hydrogen ion concentration generally takes place. The vasomotor reflexes of the body are stimulated by ultra-violet irradiation, and this leads to an improved regulation of the body temperature, so that a body habitually stifled by wearing an excessive amount of clothing becomes able to tolerate with comfort greater extremes of heat and cold. It is a common experience that less clothing is often worn after a course of irradiation.

Ultra-violet radiation provokes certain metabolic changes. It has already been mentioned that hyperglycæmia is reduced; fats are also oxidised, particularly by natural sun baths, but the most profound action is on the mineral metabolism, the body calcium, phosphorus, iron, and iodine being all increased in amount. The calcium salts play a very important part in the body economy. They have a tonic effect on the heart, they stimulate the peripheral circulation and decrease the permeability of the lymph and blood-vessels; in bleeding, their presence is essential before clotting can occur. Calcium salts also stimulate the phagocytes in the blood, and play an important part in repairing the local ravages of disease.

Ultra-violet rays probably influence the ductless glands through the medium of the sympathetic or vegetative nervous system. They stimulate the thyroid and sexual glands and cause depression of the suprarenal glands. It has been found experimentally that irradiation diminishes the acidity of the gastric juice. The ultra-violet rays act on the central nervous system, and cause mental stimulation. The cheering effect on our spirits of a bright sunny day has long been realised, and artificially produced ultra-violet rays generally have the same effect. Intelligence tests carried out at the Treloar Cripples' Hospital, Alton, proved that the children there were about a year in advance of crippled children of the same age living in London. Ultra-violet, like the infra-red rays, have an analgesic effect on the peripheral nervous system, thus relieving pain.

The ultra-violet lamp in the home can be installed in a bedroom, or preferably in a large spare room. It is certainly unwise to put it in the bathroom, because here the electrical dangers are very great, and many fatal cases of electrocution have been reported. Moreover, the steam rising from hot water in the bath would condense on the unlit lamp and cause certain metal parts to become rusty, and dampness damages insulation. For home use, a suspension type of lamp would probably prove most convenient; a beam should be found and a pulley securely fixed into it—the lamp should be counter-weighted so as to make it possible to raise or lower it at will. An arc with cored carbons often gives off unpleasant fumes, so that the ultra-violet room should be satisfactorily ventilated—cross ceiling ventilation is the ideal, but the creation of draughts must be avoided, as the open arc is very sensitive to air currents. It should be possible to heat the treatment room to a temperature of about 70°, as general treatment is always given to the nude body. Satisfactory wiring, able to carry the required load, must be installed, and if it is available, the direct current should be chosen. It is generally possible to obtain permission to use the ultra-violet lamp on the power circuit, and power rates are generally much cheaper than the rate for lighting. The polarity of the two terminals must be known, and a three pin, or non-reversible type of plug should always be fitted. There should also be a quick-break type of protected double pole switch to turn on and off the current. The fuses should be of the easy replacement type and some spare fuse wire should always be available. The lamp resistance can be mounted on the wall.

In my opinion the most trustworthy types of carbon arc lamp are (1) the 'short flame' arc taking 20 amperes, made at the Finsen Institute, Copenhagen, which can only be used with direct current (with 240 volts three lamps can be used in series), and (2) the 'long flame' arc (with 240 volts two can be used in series) designed to take 30 amperes.

The disadvantage of the short flame arcs is that the maximum exposure with them reaches 2½ hours, whereas with the long flame arc it never exceeds an hour, and when two long flame arcs are used simultaneously, one in front and the other behind, the time needed for treatment can be cut down to half an hour. The direction of the radiant emission from these two types of lamp varies considerably. The greatest ultra-violet emission from Finsen lamps is given off at an angle of about 45° to the lower carbon, whereas the maximum emission from the long flame arc is given off by the flame itself, and is therefore greatest in the horizontal direction.

With the Finsen arcs, irradiation is given while the subject is lying on a couch, first in the prone and then in the supine position. The subject should be seated on a chair during exposure to the long flame arc, and first the front of the body and then the back irradiated, the arc flame being on exactly the same horizontal plane as the lowermost ribs. If preferred, irradiation can also be made in the reclining position on a couch, the subject lying on his side and facing the lamp, and then lying on his other side with his back to the lamp. With carbon arc lamps, the distance of the subject from the lamp should be as short as the heat comfortably allows, but not too short, because burning with the infra-red rays can, of course, occur. The initial exposure to each side of the body with the short flame arc should not exceed ten minutes, and should be gradually increased to a total of seventy-five minutes, back and front. With the long flame arc fitted with white flame carbons, an exposure of each side of the body for five minutes, at a distance of approximately four feet from the arc, should be made. This time is gradually increased to a maximum of thirty minutes.

A trustworthy alarm system should be installed to give warning at the termination of the exposure, but it is generally safer for a second person to be present.

During exposure the eyes must be carefully protected with suitable glasses or some other material which is opaque to the ultra-violet rays.

Irradiation is generally carried out every other day, and can be continued regularly for months, though it is only fair to say that many actinotherapists consider that it is advantageous to make an intermission of about a month after every twelve exposures.

Ultra-Violet Radiation for Domestic Use.

By Prof. S. Russ.

IT seems very natural for people to want to make use of 'artificial sunlight' in their homes, especially during the rather sunless seasons, but there are some points which should be considered before it becomes a general practice, especially among those who seem to get along very well as they are.

In the first place, how nearly are artificial sources of radiation a copy of sunlight as it reaches most of us, nearly at sea-level? Perhaps the nearest approach to this is given by a high temperature filament lamp, though this will err on the side of having too big a proportion of radiation in the red and yellow part of the spectrum. Such lamps are of course largely used therapeutically, but mainly for the radiant heat which they give in a very convenient form.

All the forms of arc lamps, carbon, carbon-cored, tungsten, titanium, or mercury vapour, give out a composite radiation which is very different from sunlight, as it contains a large proportion of ultra-violet radiation. So that none of these sources which are often described as providing artificial sunlight can be said to do so unless a large part of the ultra-violet is screened off, and the remaining part of the spectrum very carefully compensated so as to resemble sunlight as nearly as possible.

In the second place, even if a source were invented that gave a fairly exact replica of sunlight as it comes into our houses, would it be used to any extent, and if so, for what purpose? This raises the question rather at the root of the matter; Why this quest for body irradiation? Undoubtedly much more attention is now given to housing, particularly to ventilation and lighting; it seems in fact an inevitable part of the hygienic trend which aims at abolishing the smoke pall of big cities, and the basement life which many seem able to survive. But we shall probably not be far wrong in attributing the demand for some source of artificial sunlight rather to a wish for ultra-violet radiation, and this in turn is probably due very largely to the discovery that irradiation with ultra-violet rays can cure rickets in children. It is perhaps not so much this plain fact as the story of its unfolding that has appealed so strongly to the imagination. This discovery has shown how a deficiency disease can be cured by exposing the body to radiation which penetrates but a fraction of a millimetre into the skin. The inferences

drawn from this have of course been boldly acted upon, and in consequence the substance in the skin which when irradiated produces vitamin D, the anti-rachitic factor, has been tracked down. The whole sequence of discoveries following on that of Mellanby in 1915, that rickets was a deficiency disease, forms a most impressive example of what well-directed scientific effort can achieve.

The question now before us is whether, in view of the admitted value of ultra-violet radiation in the treatment of rickets and general deficiency diseases in children, it would be a good thing for the general public to make good the deficiencies in diet (which undoubtedly affect a big proportion of the population) by exposing their bodies to frequent, perhaps daily, doses of ultra-violet radiation. The position taken up by the writer is that it is inadvisable on many grounds, and probably nationally uneconomical.

One need perhaps not lay great stress upon the fact that such a daily ray bath would cost an appreciable sum. A source suitable for home installation has to be safe; therefore it would probably have to be some form of closed arc, such as a mercury vapour lamp requiring no handling of leads from the mains. The initial cost of such a lamp, if the demand were on a big scale, might be so low as £5 or £6. Consumption might reasonably be 4 amperes at 200 volts, say 800 watts; if used daily for 10 minutes for one-half of the year, the running costs, apart from breakage and depreciation, would be 12*s*. per annum, taking power at 6*d*. per B.O.T. unit; for many households a cost that need not be taken into account, but on a big scale—a big item.

Some count should be taken of the risks run by repeated exposure of the body to a form of radiation to which it is quite unaccustomed; almost as foreign to it, in fact, as X-rays or gamma rays. Without in any way wishing to become an alarmist on the subject, I think that definite risk would be run by anyone exposing his body to repeated doses of ultra-violet radiation unless he were under proper medical supervision. The various reactions of the skin to ultra-violet radiation, which happen soon after the exposure, are well recognised by medical men, but it is too soon yet to know much about later reactions which may occur as they sometimes do after exposure to X-rays.

One very well recognised feature of prolonged exposures is the pigmentation that occurs in most, though not all, skins. If the thing were carried to extremes and people in the winter months pigmented themselves very considerably, it is open to doubt whether this would be a very good thing. Pigmentation means opacity to radiation generally, ultra-violet or luminous; and it could well be argued that in winter months one is far better guarded against heat losses by having a skin rather devoid of pigment; the general feeling of well-being quite likely depends on the tissues being illuminated to some extent by daylight.

People who spend a good part of their time in the tropics generally appear to lack vitality. There are lots of factors contributing to this, quite apart from the diseases peculiar to these zones; high temperatures and excessive humidity no doubt account for a good deal, but the continual exposure to solar radiation, besides tanning the skin, may set up other changes in the body which react upon the general vitality.

Experimentally it is found that when ergosterol is exposed to the full radiation from a mercury lamp, the amount of vitamin D gradually increases with the exposure up to a certain point, but a stage is reached when this stops. Whether this is due to the gradual formation of a neutralising body perhaps cannot yet be stated, but a recent report on nutrition by the Medical Research Council mentions that there are constituents of diet which appear to nullify the action of vitamins.

The reason for mentioning this here is that it seems a doubtful thing to advise people to install sources of ultra-violet radiation in their homes until more is known about the effects of repeated doses of these rays upon the body.

It is indeed relevant to inquire on what grounds it can be advocated. It is known that these rays can help those on an inadequate diet to avoid some of the consequences of such deficiency, but this can be done equally well by supplying the accessory food factors at much lower cost, and in a far more certain manner than by the population taking such medical matters into their own hands.

It may, however, be argued with considerable weight, that ultra-violet radiation does far more than this for people. There are some who positively hunger for sunlight and feel much fitter for some ultra-violet radiation, and the question is whether there is any valid reason why they should not have it when it can be got so easily.

The enormous sale of patent medicines throughout the country shows how willingly people will do without medical help, especially if they think the ailment a trifling one, so that there is of course nothing to prevent people getting any of the various appliances for generating ultra-violet radiation and

using them in their own homes, but surely they should not be *advised* to do so. Suppose, for example, that it were a part of the regular equipment of a household, and normally healthy children were periodically given doses of this radiation, could it be looked upon as anything short of an experiment? If so, are such domestic experiments on a large scale to be encouraged? There are many who will feel that the balance of health is maintained by so many factors, many of which are clearly recognised, that on such slender grounds it is better not to bring into this delicate balance a kind of radiation that no living race has been accustomed to before.

Medical Aspects of 'Artificial Sunlight' in Private Houses.

By P. R. Peacock, M.B., B.S.

THOUGH ultra-violet therapy has been practised in an empirical way from the earliest times, the association of sunshine with good health being in the nature of a primitive instinct, it is only during the past thirty years or so that any serious attempt has been made to establish it on a scientific basis.

Systematic clinical observation gradually led to an appreciation of the value of the alpine climate in the treatment of tuberculosis of the bones, joints, and lymph glands, and the establishment of centres for treatment of this crippling disease by heliotherapy in the Swiss Alps was largely a result of the patient work of Bernhard, followed by Rollier and others. The notable extension of ultra-violet therapy by Finsen brought the curative rays within the reach of those in comparatively sunless countries and marked the start of the modern practice of artificial actinotherapy.

The success of ultra-violet treatment for 'surgical' tuberculosis, saving as it has many children from mutilating operations, is undoubtedly one of the reasons for the popular desire for ultra-violet rays, but the more recent and far more spectacular series of discoveries linking the demonstration by Mellanby of the nature of rickets with the subsequent rapid strides of research, culminating in the synthesis of vitamin D from ergosterol by Rosenheim and Webster, probably constitutes an even stronger influence.

It is as well to have a clear idea of the real justification for ultra-violet therapy before considering the type of pseudo-medical publication or manufacturers' advertisement, from which it might be concluded that ultra-violet rays will not only prevent and cure all known diseases, but will also regulate even minor variations from the physiological standard of normality. Such one-sided propaganda has been much in evidence in recent years, and that it has borne fruit is easily judged from the number of hairdressers and beauty specialists who make a fine thing out of ultra-violet and 'violet-ray' treatments, not to mention the bottles of 'ultra-violet lubricant' and 'radioactive' bath salts, for both of which commodities the writer has been assured that there is a good demand.

In addition to the specific cure of rickets and the successful treatment of surgical tuberculosis, the value of ultra-violet rays in the treatment of septic wounds and burns was abundantly proved during the War. There is evidence that actinotherapy is of value in disturbances of the parathyroid gland and deficient calcium metabolism; possibly the rôle of ultra-violet rays is the same in these conditions as in the case of rickets, since there appears to be an intimate association between vitamin D and the absorption of calcium from the alimentary tract. Certain conditions are also directly benefited by the local reaction of the exposed part, increasing the blood supply and facilitating the removal of toxic products of the morbid state; the successful treatment of chilblains and of varicose ulcers is probably to be explained on these lines.

The powerful bactericidal action of ultra-violet rays is well known, but this property is rarely made direct use of in practice, owing to the very slight penetration of the rays, and to the fact that many of the bacteria that normally infest the skin are effectively screened from the rays in the sweat-glands or hair-follicles.

These few points have been selected from a great many known facts in order to emphasise the importance of recognising that actinotherapy is based on established facts, and it is only on such lines that it should be used. There are, however, many who would spoil a good case by overstatement, or hide their ignorance of the facts, and a dislike for critical investigation, behind a mass of plausible speculation as to some mysterious property of this or that type of arc lamp, and hinting darkly that science cannot detect properties of the rays with which nevertheless they themselves are familiar.

As there are specific cures, so there are specific diseases due to light and ultra-violet rays, and, although these are fortunately rare, they should be

considered by the advocates of wholesale light therapy. Xeroderma pigmentosum is the worst of all 'light' diseases and, in the unfortunate children affected, manifests itself as a malignant spread of pigmented spots under the influence of light, usually terminating fatally in early adolescence.

Equally rare are those cases of excessive sensitivity to light due to the presence of hæmatoporphyrin in the blood as a congenital abnormality, resulting in an eruption not unlike that of smallpox on the regions of the skin exposed to light.

Probably the greatest danger to the public from careless use of arc lamps is that of damage to the sight, a very real danger which, if not guarded against, may lead to many cases of permanent injury. Exposure of the unprotected eye to intense sources of light such as the tungsten or mercury vapour arc leads to acute conjunctivitis within a few hours, an experience that would probably induce greater caution on subsequent occasions, as few conditions are more painful. Deliberate staring at powerful sources of actinic light may lead to permanent blindness, or short of this to restriction of the visual field, the so-called 'ring scotoma.' There is a good deal of evidence that repeated exposure to unscreened arc lamps may lead to the development of cataract, and this is not surprising, since it is the lens of the eye that absorbs most of the ultra-violet rays.

If the dangers of this form of treatment have been rather stressed, it is only with the idea of emphasising that means of protection should never be neglected by anyone frequently exposed to the rays. As regards the skin, over-exposure is not as a rule followed by any permanent damage, though very painful burns and blisters are the penalty of careless handling of the lamps.

As there is no restriction of the supply of arc lamps or other apparatus for the production of ultra-violet rays to the public, the position is similar to that of patent medicines other than those scheduled under the Dangerous Drugs Acts. Inevitably, as in the case of proprietary drugs, a certain amount of amateur experimental medicine would follow the installation of arc lamps in private houses, and it cannot be too strongly pointed out that these rays are not to be regarded as practically foolproof, and should be treated with as much respect as a redhot poker or a loaded firearm.

Those who install lamps and wish to take regular doses of ultra-violet rays, would be well advised to begin by being medically examined and passed as fit for such treatment. Lamps should never be switched on until the eyes have been protected by goggles, which should be of glass tested and certified as cutting out the ultra-violet rays, and these should not be removed until the lamp has been turned off again. The technique of treatment does not come within the scope of this article, but it may be remarked that individual susceptibility varies greatly, and that this should be tested cautiously before starting general irradiation, otherwise extensive light-burns may result. The best thing would be for those who contemplate the installation of a source of ultra-violet rays to ascertain in the first instance whether they really benefit from such treatment, as by no means everyone is obviously improved by it.

One cannot help wondering whether the people who can afford to install arc lamps in their homes are those who would derive most benefit from the rays, since they are probably taking ample vitamins in their diet and live in relatively open and healthy neighbourhoods.

For the poor, whose diet is short of butter, eggs, milk, and fresh foods generally, there are already a number of clinics where they can be treated, with the best results, under proper medical supervision.

Extension of such clinics would appear to be the safest way of overcoming the defects of the rather sunless climate of Great Britain, though the intelligent use of artificial 'sunlight' in the home may be a means of improving the national health.

Lamps for Light-Baths.

By T. C. Angus.

ULTRA-VIOLET light between well-defined wave-lengths is one of the necessary accompaniments of primitive life in natural surroundings the tonic effects of which the human body is not only able to withstand, but without which it suffers a definite want. There can be no objection, therefore, to town-dwellers, during a European winter, who, while not being 'ill,' are still often in need of light and its good effects, making use of occasional light-baths from sources which emit ultra-violet light of moderate intensity. In fact, many such persons have followed this course for some time with considerable benefit, and there is little doubt that others will follow their lead.

A *practical biological measure of the strength of ultra-violet light* is the time for which it is necessary

to expose the skin to these rays for an erythema (reddening) and its after-effects to be produced. This erythema does not begin to appear until some hours after the application, and reaches its full intensity about 12 hours after the exposure, being followed by a brownish pigmentation or 'sunburn.' A band of cardboard or thick paper can be put across the abdomen, and small windows cut in this, so that the skin is exposed to the source 2 ft. away for 5 or 10 minutes and the erythema observed in each area. The dose required is that giving a slight erythema.

Lamps of various kinds capable of producing these effects after exposures of as little as two to five minutes are now obtainable through the medical stores, and can be fitted up in doctors' houses and in hospitals. Such powerful sources of light should only be used after the test of dosage by skilled people, or severe burns will result. This is obvious when it is remembered that it usually requires exposures of an hour or more to the summer mid-day sun in England to produce a sunburn on the skin of the neck or arms, so that an arc or mercury vapour lamp capable of producing this effect in five minutes must emit much more potent rays.

Lamps suitable for Domestic Use.

The Mercury Vapour Lamp.

In this well-known source of ultra-violet light the radiations are produced from an arc or stream of electrons carried by a column of mercury vapour, the whole enclosed in a quartz tube. The spectrum shows many characteristic lines of great intensity in both the near and far ultra-violet region, with much visible blue light and very little yellow and red.

A very small lamp of this kind would be suitable for the domestic use we are considering, and such a lamp would not take more than an ampere and a half after it had been alight for a few minutes.

The mercury vapour lamp is efficient and cheap in current consumption, whilst the cost of the quartz burner is lower than it was formerly, so that in price the mercury vapour lamp compares well with its rivals, and a very small lamp of this kind will be all that is desirable for domestic use. Elaborate stands and reflectors do not add to the efficiency of a lamp as they add to its cost. The quartz mercury vapour burner only requires a safe and simple support and a resistance and starting switch. The lamp is fairly cool, perfectly silent and easy to handle, though the burner is easily broken by shock or impact. The more powerful mercury vapour lamp commonly used for treatment might well be adapted for domestic use by interposing a thin filter or screen of vita-glass, which has the power of cutting off all the shorter ultra-violet rays and a proportion of those of medium length, whilst transmitting freely the near or longer rays: which last do not constitute a very powerful component of the mercury vapour lamp's output. The disadvantage of using such filters is that it is difficult to produce numbers of them with a consistent absorption, and that it would be more economical to use a much smaller and cheaper lamp to give much the same effect.

The running expenses of the mercury vapour lamp are due to current consumption, which is very small, and to deterioration of the burner, which usually has to be replaced or reconditioned after from 600 to 1000 hours' use. The atmospheric type of lamp lasts longer than the vacuum type.

Mercury vapour lamps can be made to work with direct or alternating current, lamps for the latter being rather more costly; or rectifiers can be obtained to make use of alternating current to work the direct current type of lamp.

The Arc Lamp.

This lamp has gained an unfair reputation for low output as a result of the perpetuation of obsolete designs by some manufacturers. As a result of recent improvements in lamp design and in the composition of the electrodes or carbons, therapeutic arc lamps are now obtainable that can give their effects as quickly, or more quickly, than the mercury vapour lamps commonly used.

Arc lamps using a current of three amperes, and therefore capable of being used on an ordinary lighting circuit, are now made, and these should be suitable for domestic use.

The quality and intensity of ultra-violet radiations from an arc can be varied over a wide range by the use of different electrodes—carbons cored with different metals and salts—so that the strength of the dose can be varied at will. The arc lamps used by Reyn of Copenhagen maintain a short arc between two plain carbons, the top one of which is the positive electrode. The distribution of light and ultra-violet light from such a lamp is greatest at an angle of 45° below the horizontal, and the relative strength of the biologically active rays is small compared with that of the visible light and the heat rays. Such lamps use very high currents, and the patients require exposures to them of an hour and more.

It was shown by Eidinow that the arc can be made a much more efficient source of ultra-violet light for treatment by lengthening the distance between the carbons, and by Angus by making the bottom carbon the positive instead of the top: the putting of the positive pole below ensures the diffusion up of the ionised gases and an effective flame from which most of the ultra-violet rays come. The distribution of light intensities from such an arc is nearly spherical, so that patients are best placed on the same level as the lamp. If a carbon cored with iron particles or a mixture of iron and cerium is used at the bottom, a much more powerful erythema-producing radiation is produced with which dosage time may be reduced to 2 to 5 minutes; it is then found that a plain and consequently cheaper carbon can be used in the top (negative) holder with practically no diminution of intensity of ultra-violet light from a direct current arc and a 20 per cent. diminution in an alternating current arc; this makes for a considerable saving in running

costs, because the top carbon is always the more quickly consumed.

The advantages of the arc as a source of ultra-violet light may be given as :

1. Quality and intensity of output can be varied at will by changing the electrodes.
2. No deterioration or loss of power with age.
3. A large output of warm visible light as well as ultra-violet, making the treatment pleasant.
4. Not easily broken or put out of order.

The disadvantages :

1. Uses more current than an equivalent mercury vapour lamp.
2. Carbons have to be renewed when they burn away.
3. Lamp gets hotter than mercury vapour lamp.

Precautions.

Overdosing should not be possible with lamps used for domestic self-treatment : lamps strong enough to produce overdoses should only be used under the control of a doctor.

Fire.—Lamps should be thoroughly stable and not so easily overturned that fires might be caused. All wiring and connexions should be of the best possible quality.

Electric Shocks.—Unlike the ordinary glass lamp in common use, ultra-violet lamps have one or two points where bare wires or points are exposed and may be touched when, by oversight, the current is switched on and the lamp is therefore 'alive,' although it may not be burning, and an unpleasant and even dangerous shock may thus be obtained. This may happen with the mercury vapour lamp when cleaning the burner with alcohol, as the makers recommend, and with the carbon arc when changing or renewing the electrodes ; although, of course, both these operations should be carried out before the lamps are switched on at all. This being always a potential risk, it may be well to install lamps for home treatment in the *bedroom* rather than in the *bathroom* ; this because the latter place is one in which possible shocks are far more likely to be serious on account of the large number of earthed metals and the state of moisture of floors, objects, and particularly of the body. Also, it may be well if buying an arc lamp to specify one where proper provision is made for changing electrodes without risk of shock should the switch be inadvertently left 'on.'

Care of the Eyes.—The cornea and conjunctiva are very sensitive to ultra-violet light and should always be protected by dark goggles during light treatment ; these should have close-fitting side pieces.

The relative 'cost of lamps' is as follows :

	amperes.	volts.	
Short flame Finsen arc .	.	$70 \times 110 = 7700$	watts.
Long flame arc . .	.	$25 \times 110 = 2750$	,,
Tungsten arc . .	.	$5 \times 110 = 550$	,,
Mercury vapour lamp .	.	$4 \times 110 = 440$	,,

The carbon arcs require purchase of carbons. The tungsten arcs require expensive tungsten electrodes. The mercury vapour lamp usually wants renewing after about 600-1000 hours' run, but is the cheapest.

A self-regulating long flame arc costs about £20-£25. A mercury vapour lamp without stand or reflectors costs about £10. A hand-fed tungsten arc can be made for £1 or £2. Then there are the expenses of resistance coils, wiring keys, etc.

The price of lamps is put up by provision of plated reflectors and stands. A mercury vapour lamp with an iron retort stand and a tin or cardboard screen suffices. Domestic mercury vapour lamps are now sold complete for about £10 direct, or £18 alternating current. Hand-fed arc lamps with iron and cerium cored carbons can be had for about £5. These can be run off the house circuit.

Selection of Ultra-Violet Lamps for Home Use.

By B. D. H. Watters.

THE idea of employing ultra-violet radiation at home is a new one, and there is as yet no wide selection of lamps made for this purpose. Those at present on the market must be regarded as largely experimental attempts to meet the new demand. The majority of them are of the type used for general irradiation in hospital practice, but reduced in size, and it is not generally realised that an exposed and live electrode which is safe enough in the laboratory or clinic in the hands of trained workers, may be quite definitely dangerous in the home.

The first of these lamps which were put on the market were all carbon or carbon-cored arcs, but recently the quartz mercury lamp has been produced commercially in a small size. The carbon lamps burn either plain carbon electrodes or carbon cored, with some metallic mixture which volatilises and adds the characteristic spectrum of that metal to that of the carbon arc. The metals or mixtures of metals selected are such as to enrich the arc with radiation of the shorter wave-lengths. From a therapeutic point of view, there seems little to choose between the different corings.

Carbon Arcs.

Ajax, Ltd.—The lamp is known as the 'Uviray,' and is a magnetically controlled tungsten-cored arc. It is remarkably steady in running owing to the automatic control. The arc is housed in a deep hood supported on a stand which contains the series resistance. A small knife switch is fitted to break the circuit, which serves the purpose admirably, but the fact that the contacts are so much exposed is a weak point in an otherwise good design. The current consumed is 4-5 amp. Price £5 10*s.*

Apex Sun Ray, Ltd.—The No. 1 model made by this firm is a small arc made between two thin pencils of carbon which are mounted almost

parallel in a deep metal hood. Very little adjustment is required. The series resistance is mounted on the large base of the instrument. The beam is somewhat concentrated by the narrow hood. Price £6 6*s*.

Arnold and Son (*John Bell and Croydon*).—The 'Arnold' artificial alpine sun lamp is a large and expensive instrument on a heavy stand which carries two carbon arcs in series. It is made in two sizes for 5 and 10 amp. respectively. Such a lamp is more suitable for use in a hospital than in an ordinary house. Not only is the heavy current of the larger model more than the fuses and wiring of an ordinary installation can handle, but the output of radiation is more intense than is necessary for the simple tonic treatment required. Price £20-£25.

Bower Electric, Ltd.—The 'Uvral' lamp is an interesting form of double arc. The whole instrument is housed in a teak outer case, a window being raised to expose the beam. On the side of the case is a special timing switch termed an 'expometer.' This is set for some predetermined period and the lamp switched on. At the end of the period the lamp is automatically switched off, thus reducing greatly the danger of too long exposure. The general design shows that much care has been taken to avoid accidental shock. The degree of safety has to be paid for as the price is relatively high. Current 4-5 amp. Price 24 guineas.

The 'Junior' U-V ray apparatus, by the same firm, is a much smaller apparatus. Two parallel carbon pencils are mounted in the usual hood. The series resistance takes the form of spiral coils mounted round the inside of the hood. These reach a dull-red temperature when the arc is running and radiate a certain amount of heat. The lamp requires more care and attention to use than the more expensive models. Current 4·5–5 amp. Price £5 15*s*. 6*d*.

Brodie, Oakley and Co.—'Artsun' lamp—a hand-controlled carbon arc mounted in a reflector hood. The electrodes are narrow pencils and stick out at top and bottom of the instrument quite unprotected. Price £4 17*s*. 6*d*.

Quain Ray Lamp Co.—This is also a hand-controlled carbon or cored carbon arc, but of an unusual type. The carbons are mounted horizontally in the centre of a shallow dish-shaped reflector which is covered with a grid of stout wire. The mesh is open and does not cut down the total radiation appreciably. The series resistances are radiator heating units which are also mounted in front of the reflector, so that a certain amount of heat is radiated as well as ultra-violet radiation. A switch on the back of stand serves to short-circuit the arc, when the lamp functions as a heating radiator of the usual type.

The carbons used are of medium size and burn fairly slowly, but the method of replacing them is clumsy and is likely to result in burnt fingers. There is also no main switch on the lamp itself for breaking the circuit. As the carbons burn away they have to be readjusted after a run of about ten minutes. This is claimed by the makers as an advantage, as it reduces the chance of an overdose owing to the patient going to sleep. At the same time, the output of radiation varies considerably during the ten minutes.

Rouse and Sons.—Rouse No. 1 Junior U.V. lamp. This is a simple carbon arc, the carbon pencils being mounted almost parallel in a metal hood supported on a light tripod. The series resistance is a separate unit. Tungsten electrodes can be obtained as well as plain carbon.

Mercury Lamps.

Medical Supply Association, Cox Cavendish Ltd., and other firms.—The 'Homesun' lamp is made with two types of burner for D.C. and A.C. In either form, the lamp is more constant than any of the carbon arcs, and the current consumption is only 2·0–2·5 amp. The radiation is also richer in the shorter wave-lengths of the ultra-violet, but whether that is an advantage or not is a question. The D.C. burner operates better when the current is flowing in a certain direction, but, unlike the big mercury arcs, it is not injured by being used with the polarity reversed. The mounting of the lamp is in a hood on a stand containing the series resistance. The heavy starting current which is characteristic of mercury lamps necessitates the use of fuses which will stand 6 amp. Price, D.C. £10; A.C. £18.

Medical Supply Association.—The 'Medisun' lamp is a similar instrument to the above, but requiring even less current (on D.C. 1·0–1·2 amp.). An indicating 'on and off' switch is fitted. So far as running costs only are concerned, this must be the most economical source of ultra-violet radiation available at the moment. Price, D.C. £10; A.C. £18.

Stanley Cox, Ltd.—The simple type 'Actinosun' No. 2 is a mercury lamp similar to the others described, and though not made specially for use at home, would be quite suitable for that purpose. Half-power burners can be supplied. The lamp is obtainable in two models for D.C. and A.C. respectively. Price, D.C. £9 15*s*.; A.C. £12 10*s*.

Filament Lamps with Vita-Glass.

The use of ordinary incandescent filament lamps with a vita-glass bulb for home irradiation has been somewhat superseded by these newer and more powerful lamps. The Emesay warming screen sold by the Medical Supply Association is a light radiator using ordinary bulbs, but, if the bulbs mentioned above are substituted, the screen acts as a source of weak ultra-violet of the longer wave-lengths. Such an apparatus would be free from any of the risks attendant on the ignorant or incautious use of any of the lamps described above.

Selecting a Home-Radiation Outfit.

For the purchaser and the designer of ultra-violet lamps for the home, the following points should be noted:

1. The live leads, etc., should be protected by a

deep hood or wire grid and should be as few as possible.

2. The lamp should be fitted with a good switch, in which the moving parts separate far enough to preclude all chance of arcing. A double pole type would be of advantage to ensure *both* electrodes being dead before they can be touched in the replacement of carbons, etc.

3. A well-fitting pair of goggles should always be worn. The use of goggles is so essential, especially with the small mercury arcs, that it would be an excellent thing if manufacturers agreed to mark all lamps intended for home use with the inscription, "Goggles must be worn when using this lamp." At present it is to be regretted that in a number of catalogues, etc., the artist has tried to express the pleasures of basking in artificial sunlight, but has omitted in his pictures the disfiguring goggles. The necessity of using goggles is mentioned in the catalogues, but a good illustration is often remembered when the written instructions have been mislaid. There are many satisfactory makes to be obtained, but, if there is any question, the only certain test is by spectrometer. A good pair of goggles should not transmit any ultra-violet radiation at all, not even of the longer wave-lengths.

The danger of falling asleep during the exposure is a perfectly definite one, as ultra-violet radiation often has that effect. In such a case it is possible for the patient to experience a severe blistering of the skin due to over-exposure, as this skin-burning does not appear until some time has elapsed. The simplest manner of guarding against this danger is to make it a rule always to stand up for an ultra-violet bath, and never to sit or lie down.

The most suitable place for the installation of these lamps is a matter for careful consideration. The bathroom, as has been pointed out elsewhere, is not the safest place, because of the danger of a bad shock due to the moisture present. On the other hand, it should be remembered that this radiation is a very powerful bleaching agent, and that the colours of fabrics, etc., will fade, and often the materials themselves perish, if exposed constantly to the rays.

The lamps reviewed here have been considered from the point of view of the man who wishes to have ultra-violet radiation available in his house as a tonic during the dark winter months. To use it for the treatment of any definite disease without the direction of a qualified physician is highly dangerous, for it must be realised that the irradiation used in medicine is often only a part of curative treatment. Further, there are conditions and diseases which can be made worse by ultra-violet radiation, and in spite of the enthusiastic pamphlets and catalogues which record its application in every human ill, it cannot be too strongly insisted that ultra-violet radiation is not a universal panacea.

The Ultra-Violet Transmission of Transparent Materials.

By Dr. L. C. Martin.

WE may be forgiven for a little scepticism regarding the highly coloured reports which have been current during the last few years concerning the possibilities and effects of ultra-violet radiation. It must be admitted, however, that there appears to be a considerable measure of truth in such accounts; the physicist must assist in disentangling the errors and in weighing the evidence.

The shortest wave-length for which light is visible to the eye is roughly $0{\cdot}39\mu$, but the spectrum of sunlight extends, although faintly in the end, to a wave-length of about $0{\cdot}295\mu$ at sea-level; the cornea, the outer transparent coat of the eye, transmits down to about the sunlight limit. The 'lens' of the eye is more opaque; it will not transmit beyond $0{\cdot}376\mu$, and can be made to fluoresce by radiation of about this wave-length reaching it through the cornea. Severe inflammation of the conjunctiva can be caused by exposure to intense radiation of wave-lengths shorter than about $0{\cdot}305\mu$. Physiological and germicidal actions occur with radiation of still shorter wave-lengths down to about $0{\cdot}21\mu$, but beyond this point we soon reach the region $0{\cdot}193\mu$ to $0{\cdot}185\mu$, where air becomes practically opaque. The region of interest in ultra-violet transmission measurements for present purposes extends, then, roughly from $0{\cdot}4\mu$ to $0{\cdot}2\mu$.

In connexion with the various sources for the production of ultra-violet radiation for clinical purposes, the transmission of the globes, screens, or containing vessels has to be studied; the transmission of window glass is also a special case. It may be added that the photometric study of the *emission* of the source is of no less importance. Naturally, the ultra-violet emission of many sources such as tungsten filament lamps, for which the familiar 'black-body' radiation laws are a sufficient guide, is extremely low in proportion to the total radiation. Much more energy, relatively speaking, is derived from arcs and sparks which give bright line spectra. The region $0{\cdot}4\mu$ to $0{\cdot}2\mu$ can be studied with the aid of fluorescence or photography. In some cases the absorption of media grows very rapidly with changing wave-length in a certain region; thus the simplest kind of information useful in some cases is the short wave-length limit of the transmission.

Quartz in the crystalline state is fairly transparent down to $0{\cdot}18\mu$ in pieces 2 cm. in thickness; the quartz spectrograph as made by the firms of Hilger and Bellingham and Stanley, in which the whole optical system is made in quartz, projects the entire visible and ultra-violet spectrum down to about $0{\cdot}185\mu$ on a photographic plate; the substitution of a screen of uranium glass for the plate converts the instrument into an ultra-violet spectroscope in which the lines of the spectrum are seen by fluorescence. Wave-lengths can be given by a scale marked in the glass. An iron arc or

tungsten arc gives a wealth of lines in the ultra-violet spectrum, so that if a piece of the substance under test has sufficiently good surfaces it may be held in the path of the light reaching the slit, when its 'limit of transmission' may become manifest by the darkening of the spectrum beyond a certain point. Such tests are useful for protective glasses or goggles. A compact ultra-violet spectroscope for hand use is made by Messrs. R. and J. Beck, Ltd.

Fluorite is one of the most transparent media for the ultra-violet (when pure it transmits down to 0·125μ), but it is difficult to obtain good specimens of any size, so that even its optical use is rather restricted; but this crystal, together with rocksalt and certain other crystals and gems, has important possibilities for scientific purposes.

Fused quartz is not doubly refracting, and is little less transparent than crystalline quartz; it has great resistance to heat, and its extremely high melting point makes it specially suitable for containing the mercury arc, one of the most useful sources of ultra-violet radiation. In spite of a great deal of research carried out for long periods, it has not yet been found possible to produce the material in a truly homogeneous state; there is always a residual structure showing small local variations of refractive index. Even though microscope lenses are made from it, they could be improved if the homogeneity were perfected.

The cost of using fused quartz for windows would be prohibitive, but since the range of transmission of glass can be made to include the whole sunlight range, it is unnecessary. Common soda glass is practically opaque beyond 0·33μ, but in Hovestadt's "Jena Glass" the increased ultra-violet transparency due to the use of barium is pointed out. Generally speaking, the transparency diminishes with increasing proportions of lead in the flint glasses. Researches in the effect of the composition of glass on the ultra-violet transparency have been made by Zschimmer, who found that boric oxide was very transparent. The use of sodium oxide in a glass decreased the transparency more than potassium oxide. Useful figures and curves are given by Schulz ("Das Glas," Munich; 1923. Kösel and Pustet) from the results of H. A. Kruss. Particulars are also given of the 'Uviol' Jena glass which has been most useful for spectroscopes and other purposes, since it transmits down to 0·280μ. Fritsch has published particulars of a glass made from calcium fluoride and boric oxide which is said to be transparent down to 0·185μ.

Comparatively recently, Messrs. Chance Bros. of Birmingham have brought out their 'Vita-glass' made to the specification of Lamplough. In a plate 2 mm. thick this will still transmit 10 per cent. at 0·272μ. Also, the Corning Glass Works have announced a special ultra-violet transmitting glass (not yet available in large pieces) for which an even greater transparency is claimed.

The measurement of the transmission is usually made with the aid of the spectrograph. Half the slit is illuminated by light transmitted by the specimen, the other half by an exactly similar beam, the intensity of which can be diminished (in effect at least) in definite ratios by a special device. The spectrum is thus split into two; we find the wave-lengths at which the intensity has been diminished by the specimen to those ratios used for the above device, by comparing the densities of the two parts of each spectrum photograph. The action in the variable beam can be controlled by a polarisation device or by a rotating sector; in the latter case it seems to be sufficiently accurate to assume that the reciprocity relation is valid for the plate. The optical arrangements for carrying out these tests have been so far standardised that they can be used without difficulty to obtain trustworthy results.

Special apparatus for ultra-violet spectrophotometry, for which greater speed and ease of working is claimed, has also been developed by S. Judd Lewis. Mention must also be made of the photographic methods in which special non-selective 'wedges' are employed; such methods have been worked out (chiefly for the visible region) by Mees, Dobson, and others; in some cases they can be applied to the ultra-violet.

The durability of the new glasses referred to above can only be tested properly by experience. One important matter is their stability under the continuous action of ultra-violet radiation. Some glasses containing small amounts of manganese are well known to develop a pink tinge when used in globes round arc lamps; such action under exposure to intense radiation is likely seriously to prejudice the ultra-violet transmission, and effects of a similar kind should be looked for even in the absence of manganese. Naturally, the relation between the conditions of normal use and the conditions of the test would have to be carefully considered.

Important questions are likely to arise in connexion with the screening off of undesirable components of the radiation; it is possible that liquid 'filters' may become useful in such cases. Much information on recent work on the transmission of liquids is given in Luckiesh's useful book on "Ultra-violet Radiation," and recent work on the transmission of solutions has also been carried out by Dahm.

In conclusion, it may be said that photometric methods are so far developed that it should not be difficult to measure and to control the characteristics and intensity of any ultra-violet radiation used for medical purposes. In the somewhat arbitrary and experimental condition of present practice, it is not possible to be too precise and definite in the specification of physical conditions.

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News and Views.

IN an address on "Science and the Civil Service," given in November last to the Professional Institute of the Civil Service in Canada, Prof. J. C. McLennan reminded his audience, which included members of the Canadian Cabinet, of the benefits which scientific workers employed by the State have conferred on the populations in the Dominion. So far from scientific men being mere 'high-brows,' unpractical dreamers, and visionaries whose services are worth a mere pittance, they are more practical than the arm-chair politicians who despise science. It was a member of the Geological Survey of Canada, Dr. Dawson, who discovered the famous gold-bearing belt in the Yukon territory. It was largely owing to Prof. Miller and his colleague, Mr. Thomas Gibson, that a mining policy for the development of the silver, nickel, copper, gold, and other metallic mineral fields in Ontario was inaugurated. Canada's remarkable success in agriculture was based on the work of two public servants, Dr. William Saunders, who created the Experimental Farm System, and his son Dr. Charles Saunders, who discovered the Marquis variety of wheat. To another, Dr. Gordon Hewitt, who developed the Dominion Entomological Service and devised means for the control of grasshopper pests, must be given the credit of saving Canadian farmers millions of dollars yearly. The list of services rendered to the material prosperity of Canada by scientific workers in the public services could be extended indefinitely. For the most part they have worked for wretched salaries and, in some cases, with but the most meagre recognition of their great works. It is time the statesmen of the Dominion realised the immense potentialities of properly endowed scientific services.

PROF. MCLENNAN did well to point out to the statesmen and other public men present that if the scientific services are starved in Canada, the best brains of the community will continue to migrate to its great neighbour, where they can expect greater encouragement and more freedom to apply their discoveries. The tendency on the part of the wealthy and financial houses to send money to the neighbouring State for investment is a direct consequence of the apathetic attitude of the Dominion Government towards scientific research. Money now goes for investment and people of ability for employment to places where science is appreciated, where invention and discovery find application in industry. Scientific workers, by the discoveries and advances they are making continually, not only stabilise industries, but also point the way for still greater developments. The best protection for Canada is the adoption of a policy "Science in the Civil Service and Science in Industry." Canada badly needs a National Research Institute in which those scientifically inclined, or those in control of industries, can have their problems investigated. With this view the Hon. Charles Stewart, Minister of the Interior, entirely agreed, and made the useful suggestion that the scientific workers of Canada, led by Prof. McLennan, should go out into the highways and byways and convert the laymen of Canada, who wield the 'big stick' to urge on or frighten members of Parliament, to the need for and value of scientific research.

AT the risk of appearing tedious, anthropologists continue, and wisely, to urge the importance of their studies for purposes of administration among backward races. The latest pronouncement is by Mr. J. H. Hutton, of Assam, who is well qualified to speak both as an anthropologist and an official. In his presidential address to the Anthropological Section at the Calcutta meeting of the Indian Science Congress last January, he argues ably for the utility, and indeed the essential need, of a knowledge of the principles of the science in dealing with such a people as that with which he is most familiar, namely, the Nagas. He points his argument with many an apt illustration in which knowledge of sentiment and custom, especially in the judicial field, has been an essential condition to secure the right handling of incidents such as crop up daily in the path of the administrator. He deals with the difficult question of missionary activity temperately, even though he is compelled to conclude that their influence is in practice harmful, as it breaks bonds which form part of the tribal complex, but for which Christianity affords no substitute to help the native. Supporters of the missionary, it may be noted in passing, who think that Christianity should be able to afford the necessary influence to replace tribal custom, in arguing from the analogy of a Christian society, overlook the fact that ethics are fundamentally cultural even when they have a theological sanction, and to a great extent cannot be transposed from one sytem to another. Mr. Hutton's careful analysis of the results which arise from culture contact between east and west to the detriment of the health and numbers of the native population constitutes a warning against the too hasty introduction of civilising influences, which deserves careful pondering by those who are interested in the advance of backward peoples.

A PAPER was read on Mar. 30 by Mr. D. Brownlie, before the Diesel Engine Users' Association, on the subject of liquid fuel from coal. He pointed out how necessary a supply of liquid fuel produced in Great Britain will be if the Diesel engine is to attain an importance commensurate with its thermal efficiency. This supply may be derived from coal by carbonisation at high or low temperatures, by hydrogenation, or by synthetic processes based on carbon monoxide. The author dealt with these methods *seriatim*—in particular with the carbonisation of coal at low temperatures, on which he listed seventy-five different processes, describing thirty of major importance which have been in more or less continuous operation in large-scale plant. Hydrogenation and synthetic fuel production were described in outline. The author deplored the slow advance of the production of liquid fuel from British coal, and indulged in a jeremiad on the absence of scientific development of

our home resources. It is easy to exaggerate here, for there has been no lack of ingenuity applied to the carbonisation of coal by British workers. About a third of the processes scheduled by the author are of British origin or development; undeniably capitalists have not withheld ample financial support, as many of them would ruefully agree. The author himself throws light on the slow progress when he enlarges on the development of mineral oil production. Oil *can* be produced from coal, but *must* be sold in competition with natural petroleum, and present-day economic conditions do not lighten the task of those who seek to manufacture liquid fuel from coal.

"THE Agricultural Depression, its Causes and Possible Cures," was the subject of an address by Mr. W. C. D. Dampier-Whetham at the ordinary general meeting of the Surveyors' Institution, held on April 2. A comparison of the present situation with previous depressions shows that all have occurred during times of falling prices in both agriculture and industry and are ultimately due to monetary instability. After discussing the theory of prices, Mr. Dampier-Whetham showed that the general changes in price level from 1843 to 1914 are explained by the varying relations between the world's supply of and demand for gold. Whereas plentiful gold invariably results in an increase of prices and prosperity for the farmer, depressions arise from a falling average level of prices, whether this be due to shortage of gold as in 1873, or to deliberate deflation as in 1920, when efforts were made to restore the gold standard. Protection or free trade has less effect on prices than changes in the value of money. As regards possible remedies for the existing depression, much may depend on the policy of the Federal Reserve Board and possibly on some future international agreement as to the control of the world's gold supply. A system, other than the gold standard, may ultimately be devised for the management of currency and credit, which will tend to keep the index number of wholesale prices constant, and counteract the effects of a probable world shortage of gold. Although such fundamental changes may be premature, some measure of relief will be obtained if efforts are made by the farmers themselves to reduce costs and charges in every possible way, particularly in the sheltered industries, and the questions of marketing, import control, and agricultural credit are still further explored by the Government. The only radical cure, however, is stabilisation of the general price-level, that is, of the value of money.

THE contrast between the Building Exhibition of to-day and those that were held in former years at the Agricultural Hall is very marked. Those at Islington were well attended, it is true; for architects, builders, and others of such groups went there in order to gain up-to-date knowledge of marketed goods and processes; but it was purely as a duty that the journey was undertaken. Since Mr. Greville Montgomery has organised the show at Olympia, the duty of attendance has become a real pleasure. Environment and district have not a little influence in the change of sentiment; Kensington against Islington, for north is north, and west is west, "and never the twain shall meet." But the character of the display is a more powerful influence still. One outstanding feature is, that all the exhibitors may be regarded as having some association with building; and, again, there are no extraneous attractions, with the exception of good music. The Government shows its sense of the value of the exhibition by having representative departments there; there is the Empire Marketing Board, the name being self-explanatory; and at this stall are to be seen several interesting tests results upon timber beams carried out by the Forest Products Research Laboratory. The Department of Scientific and Industrial Research supplies information as to the work carried on at the Building Research Station near Watford, to which reference was made lately in our columns. As the majority of people are interested in building in one form or another, the attendances at Olympia are naturally large; the goods are attractively displayed, and inquiries are dealt with intelligently. The work of various arts and crafts training institutes forms a feature, and there is also an admirable loan collection of antique and modern furniture, the latter from the designs of well-known architects and others. Altogether, there are close upon four hundred exhibitors.

THE trans-Atlantic flight from east to west by a heavier-than-air machine has at last been accomplished. Capt. Hermann Köhl, Commandant James Fitzmaurice, and Baron von Hünefeld started from Baldonnel aerodrome, near Dublin, in the *Bremen*, early in the morning of April 12, and landed at Greenly Island in the Strait of Belle Isle on the following day. Capt. Köhl, manager of the night-flying department of the Deutsche Lufthansa, and Baron von Hünefeld, with a mechanic, flew from Berlin to Dublin on Mar. 26, where they had to await favourable weather conditions for their Atlantic flight. The mechanic was replaced by Commandant Fitzmaurice, acting officer in command of the Irish Free State Air Service, who acted as second pilot when the flight began on April 12. The *Bremen* is a Junker metal monoplane fitted with a 200 k.w. Junker engine. A rough analysis gives aeroplane weight as 1·2 tonnes; crew, etc., 0·2 tonne; fuel and oil 1·6 tonnes, giving 40 hours' flight at cruising speed 150 km./hr., that is, a range of 6000 km. in calm air. The actual geographical distance covered was about 3500 k.m., so that changes in course and head winds reduced the effective speed to about 90 k.m./hr. Herein lies the patent secret of previous failures. A small circle of about 3500 km. with Dublin as centre grazes the North American coast at Greenly Island, the landing point, from which we may infer that another disaster was averted by a sound decision, good navigation, and the last litre of fuel. Capt. Köhl and Baron von Hünefeld attempted a trans-Atlantic flight from east to west last August, but, after making their way from Dessau across England and Ireland, they were forced to turn back by bad weather and lack of fuel.

A PRELIMINARY notice of the International Meeting of Geologists to be held in Copenhagen on June 25–28, on the occasion of the fortieth anniversary of the Geological Survey of Denmark, has already appeared (NATURE, Dec. 17, 1927, p. 890). The provisional programme of excursions has now been revised. Excursions before the meeting are as follows: June 17–20, to Bornholm; June 21–24, to South Sjælland and the Island of Möen. After the meeting a longer excursion, June 29–July 9, is being organised to north-west Sjælland, Fyn and the Island of Langeland, and Jutland. Geologists who are returning to England or France from Esbjerg will have an opportunity of seeing the Yoldia clay of the Mindel-Riss interglacial episode. The number of participants in each excursion is to be limited, and notice of intention to attend should be sent as soon as possible, and in any case before May 1. Full details of cost, itineraries, and accommodation will be found in the second invitation circular, which can be obtained from the Secretary, International Geological Meeting, Danmarks Geologiske Undersögelse, Gammelmönt 14, Copenhagen K, to whom all other relevant inquiries should be addressed.

MARSTON TAYLOR BOGERT, senior professor of organic chemistry at the Columbia University, New York, who celebrated his sixtieth birthday on April 18, spent the past winter in Prague as the first visiting professor for international relations to Czechoslovakia sent by the Carnegie Endowment for International Peace. As the guest of the Charles' University he delivered five highly interesting lectures on his original researches on thiazoles and selenazoles; odour and chemical constitution; science and industry; science, the individual, and the State; science in the interest of peace. He also gave similar lectures at the Universities in Brno, Moravia, and Bratislava, Slovakia. The Charles' University Medal has been awarded to Prof. Bogert for his work for the advancement of science, and the honorary degree of Doctor Rerum Naturalium of the Charles' University has been conferred upon him for his discoveries and researches in organic and applied chemistry.

PROF. YUKICHI OSAKA has recently retired from the chair of physical chemistry which he has held for twenty-three years at the Kyoto Imperial University. An account of his career by S. Horiba, with a photograph, is given in the *Bulletin of the Chemical Society of Japan* for January. Prof. Osaka came to Europe in 1899, having already had some experience of teaching chemistry, and studied under Ostwald and Nernst. Four years later he was appointed to the chair of applied electrochemistry at Kyoto, but very soon became professor of physical chemistry. He is best known for his work upon heterogeneous equilibria, although he has also conducted researches upon the catalytic effect of the hydroxyl ion and upon overvoltage. Prof. Osaka is sixty years of age, and his latest paper also appears in the above journal.

DR. ROY CHAPMAN ANDREWS, after maintaining the headquarters of the Expedition of the American Museum of Natural History to Central Mongolia immobile at Peking for a period of two years owing to political troubles in China, has now left Kalgan to resume work in the desert. According to the Peking correspondent of the *Times* in a dispatch in the issue of April 17, he hopes to ensure the safety of the expedition by a capital payment to the Chief Officer of the brigands of the area, a monthly subsidy, and a sum equal to the first capital payment if the expedition returns safely. The expedition consists of ten Americans, experts in palæontology, geology, archæology, and topography, and a surgeon, a photographer, and two motor experts, with twenty-six Mongols and Chinese. The expedition will continue its search for traces of earliest man, and in addition of the five-toed horse, believed to be the progenitor of the four-toed fossil horse of Europe and America.

As promised, the results of Prof. Trombetti's researches in the Etruscan language, following his investigation of the "Liber Linteus," the linen book, in which the mummy of an Etruscan lady, discovered in Egypt and now at Agram, had been wrapped, were duly laid before the first International Congress of Linguists which opened at The Hague on April 10. Prof. Trombetti gave it as his opinion that Etruscan could not be regarded as an isolated language, but showed close relation to the Indo-European and belonged to the group in which the pre-Hellenic languages of Asia Minor were to be found. Of the twelve chapters of the "Liber Linteus," one was said to bear every indication of being an account of the *lectisternium*, *i.e.* the meal provided for the images of various gods, while others contained a litany, an enumeration of the *Cepen* or magistrates, and a calendar giving the dates of various festivals.

WE learn from a *Daily Science News Bulletin*, issued by Science Service of Washington, that F. W. Peek has been able to store in a suitable condenser and discharge electricity at a pressure of three million six hundred thousand volts. The experiments were carried out at the Pittsfield laboratory of the General Electric Company. The object of the research was to imitate as closely as possible the phenomena that happen during a lightning discharge from a cloud, so as to help in designing effective lightning conductors and safety devices. Although the spark lasted less than a millionth of a second, yet its growth and decay were accurately measured by a cathode ray oscillograph, which uses a beam of electrons for a pointer. In some cases the flash lasted only the ten-millionth of a second. Remembering that light travels with a velocity of 3×10^{10} cm. per second, the flash will be over by the time the light has travelled a hundred feet from the spark.

THE following appointments have been made by the Secretary of State for the Colonies: Mr. S. Gillett to be assistant agricultural officer, Kenya; Mr. W. H. W. Baird, to be entomologist, Veterinary Department, Tanganyika Territory; Dr. R. R. Le Geyt Worsley, formerly sub-director of the Chemical Section, Egypt, to be chemist, East African Agricultural Research Institute, Tanganyika Territory;

Mr. J. G. Brash and Mr. J. C. Bytheway, to be produce inspectors, Nigeria. Recent transfers and promotions made by the Secretary of State include: Mr. R. A. Altson, formerly assistant botanist and mycologist, British Guiana, to be assistant mycologist, Department of Agriculture, Federated Malay States and Straits Settlements; Mr. J. T. Templer, formerly administrative cadet, Tanganyika Territory, to be assistant conservator of Forests, Uganda. Mr. Baird's appointment is of interest in that it appears to be the first appointment, on a permanent basis, of an entomologist to a veterinary department in the Colonial Services.

FARMERS' and farm workers' associations and clubs, chambers of agriculture and horticulture, students' societies, and other bodies interested in agriculture or market gardening are again being invited to inspect the Rothamsted and Woburn Experimental Plots during the coming summer. Mr. H. V. Garner and Capt. E. H. Gregory will be available to demonstrate the plots at any time. At Rothamsted the soil is heavy. The experiments deal with the manuring of arable crops, especially sugar beet, potatoes, mangolds, barley, oats, wheat; manuring of meadow hay; effect of modern slags and mineral phosphates on grazing land and hay land; inoculation of lucerne; crop diseases and pests; new experiments are in progress on the laying down of land to grass; demonstrations of modern implements, tractors, and good types of tillages. At Woburn the soil is light. The experiments there are concerned more particularly with the manuring of potatoes, sugar beet, wheat, malting barley, and the use of green manures. All communications and requests to visit the Stations should be addressed to the Secretary, Rothamsted Experimental Station, Harpenden.

THE Faraday Medal of the Institution of Electrical Engineers will be presented to Prof. J. A. Fleming at the ordinary meeting of the Institution to be held on Thursday, April 19, at 6 P.M. The presentation will precede the nineteenth Kelvin Lecture, by Sir Oliver Lodge, on "The Revolution in Physics."

A VIOLENT earthquake was recorded at Kew Observatory on April 16 at 9 h. 4 min. 32 sec. G.M.T. The epicentre is estimated to be 1430 miles away, probably near the western coast of the Black Sea. The disturbance at Kew was of about the same intensity as that produced by the destructive earthquake which occurred near Smyrna on Mar. 31.

THE Council of the Institution of Automobile Engineers has awarded the Institution Medal to Major G. S. Wilkinson for the prominent part taken by him in the design of the Napier Lion 875 h.p. engine fitted to the Supermarine-Napier S5 with which Flight-Lieutenant S. N. Webster won the Schneider Trophy Race in September last.

IT will be remembered that at an extraordinary meeting of the general committee of the British Association held on Dec. 2, it was resolved to apply for a Royal Charter for the Association. Mr. A. A. Campbell Swinton very generously offered to bear the cost of obtaining the Charter. It is now announced that His Majesty the King in Council has been pleased to grant the petition of the British Association.

THE recently issued catalogue of Judex Analytical Reagents and Laboratory Chemicals, issued by the General Chemical and Pharmaceutical Co., Ltd., Willesden, includes a wide range of inorganic and organic chemicals. Among them are analytical reagents of guaranteed purity, standard solutions for volumetric analysis, special reagents for use in the analysis of water, gas, milk, sugar, urine, iron and steel, volumetric solutions of the "British Pharmacopœia," indicators, chemicals for electroplating, accumulator acid, etc. Besides supplying rare chemicals for research and analysis, the firm undertakes the manufacture of large or small amounts of unusual substances required for special purposes.

THE "Statistical Report of the Health of the Navy for the Year 1925" and the "Report on the Health of the Army for the Year 1926" have recently been issued by the Admiralty and the War Office respectively (London: H.M. Stationery Office). As regards the Navy, the returns for the total force for the year show a decrease in the incidence of disease as compared with the previous four years' average and with 1924. In the Army, the incidence of sickness was a trifle higher than in 1925. The incidence of tonsillitis again increased, and as a cause of admission to hospital took second place; all attempts to elucidate the cause of this high incidence have so far failed. Middle ear disease, as in the previous year, heads the list of causes of invaliding.

HISTORICAL details given in a catalogue issued by Messrs. W. Ottway and Co., Ltd., manufacturers of optical and scientific instruments, Orion Works, Ealing, W.5, show that the foundations of the business were laid about three hundred years ago. In 1640, the shop at the Royal Exchange occupied by Thomas Francis Ottway, a maker of instruments of a scientific nature, was destroyed by the fire which devastated central London. The business was afterwards carried on at various addresses until 1900, when the present works at Ealing were opened. The firm is still owned and managed by descendants of the original founder, and their works are now so well equipped as to enable the company to manufacture all the various parts required for the instruments produced by them. These include equatorial mountings for reflecting and for refracting telescopes; astronomical transits; astronomical clocks and chronographs; cœlostats with driving clocks and with mirrors up to 18 inches in diameter; control instruments for controlling electrically the driving clocks of astronomical instruments; and a wide range of astronomical telescopes with object glasses up to 5 inches aperture. The instruments mentioned are fully described and illustrated in the catalogue, which contains also a list of various types of naval, military, and sporting telescopes. Achromatic object

glasses up to 6 inches clear aperture and 90 inches focal length, heliographs, prismatic compasses, and prismatic binoculars are also included.

The 1928 edition of "British Spas and Climatic Health Resorts" has recently been published (London: J. and A. Churchill. 1s.). It gives much information concerning the choice of waters and climates and on British and Irish marine and inland health resorts. Lists of the residential accommodation available in the principal resorts are furnished.

In connexion with the tercentenary of the publication of Harvey's "De Motu Cordis," the Cambridge University Press will issue a limited edition of "A Bibliography of the Works of William Harvey," compiled by Mr. Geoffrey Keynes. The work will be illustrated by a number of collotypes and facsimiles in line. The same house also announces "The Theory of Probability," which Prof. W. Burnside had almost completed at the time of his death. The volume has been seen through the press by Dr. A. R. Forsyth, and includes the memoir of the author which Dr. Forsyth wrote for the Royal Society.

Applications are invited for the following appointments, on or before the dates mentioned:—An assistant part-time lecturer in the biology department of the Plymouth and Devonport Technical College—The Secretary for Education, Education Office, Cobourg Street, Plymouth (April 28). A district agricultural organiser under the Essex Agricultural Committee (on the Staff of the East Anglian Institute of Agriculture)—The Clerk of the Essex County Council, Shire Hall, Chelmsford (April 30). Professorships of geography, medieval history, Egyptian and Oriental history prior to Græco-Roman times, classics and Græco-Roman history, in the Egyptian University, Cairo—The Director, Egyptian Educational Office, 39 Victoria Street, S.W.1 (April 30). A professor of botany in the Egyptian University, Cairo—The Dean of the Faculty of Science, Egyptian University, Cairo (April 30). A junior assistant (engineer) at the Building Research Station, Watford—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (April 30). A government analyst and bacteriologist for Cyprus—The Private Secretary (Appointments), Colonial Office, 2 Richmond Terrace, Whitehall, S.W.1 (May 7). A lecturer in physics in the University of Western Australia—The Agent-General for Western Australia, Savoy House, 115 Strand, W.C.2 (May 9). Head of the architectural, building and surveying department of the Northern Polytechnic—The Clerk to the Governors, Northern Polytechnic, Holloway, N.7 (May 11). A temporary agricultural entomologist in Fiji and, possibly, afterwards in the British Solomon Islands Protectorate—The Private Secretary (Appointments), Colonial Office, 2 Richmond Terrace, Whitehall, S.W.1 (May 21). An assistant professor in the department of mathematics of the Imperial College of Science and Technology—The Secretary, Imperial College of Science and Technology, South Kensington, S.W.7 (May 25). A curator of the Gloucester Museum—Mr. St. Clair Baddeley, Castle Hale, Painswick, Gloucestershire.

Our Astronomical Column.

Nova Pictoris.—Another telegram from Mr. Wood at Johannesburg was distributed from the I.A.U. Bureau, Copenhagen, on April 14. It states that the Nova is now surrounded by a ring 3 minutes of arc in diameter, with two smaller rings inside it. These rings are clearly much too large to be produced by the outward motion of matter from the Nova since the outburst in 1925. We may assume that they are similar to the nebulosity photographed round Nova Persei in the autumn of 1901, which was explained by the hypothesis that the nebulosity was previously there in a dark state, and became visible by reflecting the light of the outburst.

Pop. Astron. for April states that the magnitude of the Nova in mid-December last was 6·77. As it is falling at the rate of a magnitude per annum, it is probably a little fainter than mag. 7 at present. Several of the daily papers erroneously gave its present magnitude as about 11.

Comets.—M. Mineur obtained an observation at Paris on Mar. 28 of the comet detected on Mar. 17 by M. Giacobini; the following are the two positions:

	R.A.	N. Decl.	Mag.
Mar. 17. 9264 .	$5^h\ 50^m\ 0^s$	14° 35′ ″	11
28. 9585 .	6 12 26·5	14 57 39	10½

The daily motion on Mar. 28 was given as $+3\frac{1}{4}^{min}$ in R.A., 0′ in decl. The position on April 21 may be about 8^h in R.A., 14° in decl.

Dr. C. P. Olivier states in *Pop. Ast.* for April that the comet Pons Winnecke yielded a rich shower of meteors on June 23 last. Meteors were fairly numerous on June 26-29.

April Shower of Meteors.—These meteors may be expected on April 21, and should attain a maximum either in the morning or evening of that date. Moonlight will not interfere with the display should it actively return this year. The shower is no doubt a periodical one, but the exact period, or that of the supposed associated comet 1861 I, is not known. Apparently the earliest exhibition of the meteors occurred in 687 B.C., and later returns possibly occurred in 15 B.C. and A.D. 582, but identity may not be absolutely certain though the dates conform within small limits.

April is one of the spring months when meteors are generally rare, so that, should the Lyrids fail to present themselves, meteoric apparitions are somewhat scarce, and long vigils are not suitably rewarded. But the special Lyrid shower may develop unusual strength at any time and amply repay observation. The sky should be attentively watched every year at the end of the third week in April, for evidence as to the character of the shower's return cannot fail to add to our knowledge.

On April 21, before daylight, the radiant will be very high and favourably placed for the visibility of its meteors, but the evening hours between 10 and 12 are indicated as the most probable time for the earth's passage through the denser part of the stream. At the latter time the radiant is in the north-east and not very high. Observations of the paths of any bright meteors that may appear will be valuable, whether they belong to the system of Lyrids or to one of the minor displays of this epoch.

Research Items.

LUBAANTUN.—In vol. 57 (1927), Pt. 2, of the *Journal of the Royal Anthropological Institute*, Mr. T. A. Joyce, with the assistance of notes contributed by Mr. Cooper Clark and Mr. J. E. Thompson, reports on the excavations which he conducted on behalf of the British Museum on the Lubaantun site in British Honduras in 1927. The excavation of the megalithic hill-terraces, discovered in the previous year, was continued. It is now confirmed that these terraces were constructed before the two large pyramids, and probably constitute the earliest phase of architecture on the site. Excavations to the north of Mound *S*, as it is now known, in search of a continuation of the megalithic hill-terraces, while unsuccessful in finding them, produced clear indication of five architectural periods. The earliest phase of building laid bare at this point consisted of a stairway which ran under the mound. It was approached by an inclined stucco flooring. Behind the stairway was a wall built against the hill-side, which may be earlier than the steps, or may have been built as a containing wall to enable them to be constructed. Examination of the exposed surface of the whole pyramid suggested to Mr. Thompson that the remarkable in-and-out style of architecture may have been the result of disintegration rather than an artificial and conscious product; but Mr. Joyce is not inclined to agree, especially as this style occurs only in the Lubaantun area and not elsewhere as might be expected if it were the result of disintegration. Mounds *D*, *F*, and *G* were also excavated and produced a considerable number of relics. A platform in mound *G* would appear to have carried a wooden structure which was destroyed by fire. The floor was covered with three feet of burnt clay mixed with wood ash. Old Empire pottery of excellent style precluded any possibility that the structure dated from a re-occupation of the site.

VITAMIN CONCENTRATES FOR MARGARINE.—It is generally conceded that the average consumption of fat in Great Britain is below the optimum, and also that a proportion, sometimes the major part, of that consumed is in the form of vegetable fat (or margarine). Now, although an animal fat can be replaced in the diet by isodynamic amounts of carbohydrate, protein or vegetable fat, so far as the supply of energy to the body is concerned, yet none of these other foodstuffs can supply the fat soluble vitamins A and D, which are present in varying degree in the different animal fats. The importance of these vitamins for the maintenance of general health and wellbeing and the prevention of certain diseases need scarcely be emphasised at the present time. The drawback to an increased consumption of animal fat is the cost of such products, hence a more practicable alternative would seem to be the enrichment of vegetable margarines with a source of the fat soluble vitamins. Messrs. Planters Foods Ltd., Brombro Port, Cheshire, have recently put on the market several brands of vitamin margarine: each contains a sufficiency of their vitamin concentrate 'Essogen' to bring the potency of the margarine up to that of the best summer butter. The potency of the products is controlled by experimental feeding tests. The addition of the concentrate has no deleterious effect upon the taste or palatability of the margarines.

BODY DEFENCE AGAINST PATHOGENIC ORGANISMS.—Di Cristina's views on the processes by means of which the animal organism defends itself against infection is the subject of a communication by Caronia in the *Atti della Pontificia Accademia delle Scienze* for 1927. The results of more than ten years' work in the vaccine therapy of infectious diseases have led di Cristina to the conclusion that Ehrlich's original conception of immunity, according to which the defensive mechanism of the organism is based on the struggle between antigens and anti-body, neither corresponds with the facts nor explains the processes of cure. The infected organism is highly sensitive to the protein homologous to the pathogenic germ and remains so until the infection becomes extinguished naturally. Thus a direct relationship exists between the condition of hypersensitisation and the disease, and this stands out the more clearly as the special property acquired by the organism to withstand the action of the bacterial protein is the more marked. Cure occurs gradually as the organism becomes desensitised. The desensitisation, which takes place naturally in the case of spontaneous cure, is best effected artificially by the intravenous or subcutaneous administration of small doses of protein derived from the corresponding pathogenic agent. The antigen thus introduced leads, by true anaphylactic reactions, to complete desensitisation in a period varying with the method employed. The actual mechanism of this process is still obscure, but probably depends on phenomena originating at the expense of the equilibrium of the colloids of the tissues, new conditions, which prevent further development of the pathogenic action of the germs, being thus determined.

MICROBIOLOGICAL OBSERVATIONS AT NOVAYA ZEMLYA.—A. F. Kazansky, who is microbiologist of the Russian Academy of Science, according to the *Information Bulletin* of the Academy, has recently returned from an expedition to Novaya Zemlya, where he studied the microflora during the winter and summer of 1927. Microflora of the air proved to be remarkably poor, especially in winter, when Petri dishes with media remained sterile after long exposures; only in a few cases were micro-organisms found when the dishes were exposed near to habitations. In summer some micro-organisms were observed more regularly, up to 13 in one dish, but on the average only 1-3, while many dishes remained sterile even after exposures for an hour. Sterilised meat exposed for eight months, from February to September, remained fresh, though microscopic analysis revealed the presence of some micro-organisms. Analysis of snow gave in most cases negative results, but during summer the number of bacteria in snow was greater than in the air. Study of the soil microflora revealed the presence of atmospheric nitrogen fixing bacteria, nitrifying and denitrifying bacteria, and bacteria causing aerobic decomposition of cellulose. More detailed studies of the organisms found will be continued in the Academy laboratories in Leningrad.

MOUTH-PARTS OF A BLOOD-SUCKING MIDGE.—In the *Bulletin of Entomological Research*, vol. 18, Feb. 1928, Mr. B. Jobling provides an illustrated account of the structure of the head and mouth-parts of the common blood-sucking midge *Culicoides pulicaris* L. Among various features described in this detailed study it is noteworthy that, unlike many blood-sucking flies, mandibles are present in both sexes, although weakly developed in the males. The labrum-epipharynx, hypopharynx, and mandibles form together a piercing organ which is driven into the skin of the person or animal attacked. The

galeæ of the maxillæ are blade-like, with numerous fine teeth distally, but being only partially chitinised they evidently perform merely an accessory function in piercing. The labium plays no part in the process, but serves to maintain the other organs in position. The author follows Frey, Crampton, and others in regarding the labella as the modified labial palps. The intense irritation caused by the punctures of these minute flies is alleviated if the lesion be moistened and rubbed with a crystal of sodium carbonate. The author states that with this application it ceases in a few seconds and does not recur.

LAKE MICHIGAN PLANKTON.—Mr. Samuel Eddy ("The Plankton of Lake Michigan," State of Illinois Department of Registration and Education. Division of the Natural History Survey. Bulletin, vol. 17, art. 4, 1927) bases his account of the plankton from the inshore waters of Lake Michigan on two collections taken respectively in 1887–88 from November to October, and in 1926–27 in October, May, and July. These were worked out qualitatively, and in the later collection also quantitatively, the chief purposes being to present a general picture of the plankton of Lake Michigan, to determine the relative abundance of the constituent organisms and to incorporate and summarise the facts now known relating to the plankton of the Great Lakes. The physical conditions in Lake Michigan vary little from year to year, and variation among the plankton organisms is slight. A comparison of the two collections shows little change in the plankton over the period of forty years, the only notable exception being the copepod *Epischura lacustris* Forbes, which was abundant in the early collection but absent altogether later. This may be due to larger nets being used, as more of the larger and less of the smaller plankton animals were present in the earlier collection generally. The seasonal changes are slight, but in 1887–88 the animal plankton decreased in the cold weather and was almost entirely absent from December to March. The plankton is characteristic of a large and deep lake. The chief constituents are diatoms; especially Asterionella, Striatella, and Fragilaria. There are a few Cyanophyceæ and Chlorophyceæ, only two peridinians, and the metazoa are represented by Hydra, nematodes, rotifers, Cladocera, and copepods.

SURVEY IN THE GOLD COAST COLONY AND PROTECTORATE.—The *Report* of the Survey Department for 1926–27 records that nearly two-thirds of the total area, including the mandated territories on the east, have now been surveyed. The parts that remain to be surveyed are mainly in the north-east of Ashanti, the west of the Northern Territories, and the mandated territories which were formerly part of Togoland. The total number of one-inch sheets printed is eighty-two, and of half-inch sheets twenty. In recent years the department has had not only its own school of instruction for native surveyors but also its own printing establishment. It is of interest to note that during the season when the harmattan blows, which is chiefly in January, all colour printing has to cease. This dry wind following rapidly on humid conditions causes a change in the area of the paper of as much as a quarter of an inch in a sheet two feet square, making it impossible to secure registration. The department has also produced a wall map of the Colony for the use of schools. The *Report* contains indices of the published sheets.

THE LANCASHIRE COALFIELD.—Another addition has been made to the valuable series which is being gradually issued by the Fuel Research Division of the Department of Scientific and Industrial Research (*Physical and Chemical Survey of the National Coal Resources*, No. 10, The Lancashire Coalfield, The Wigan Four-Feet Seam. London: H.M. Stationery Office). It contains a complete description of the character and composition of the important seam known as the Wigan Four-Feet Seam, as well as by a number of other names which appear to be variations of the words 'Ell Hole.' It occurs throughout the South Lancashire Coalfield, its thickness increasing with considerable regularity from about 2 ft. in the eastern portion of the Coalfield to a maximum of 6 ft. 3 in. at Garswood, and getting slightly thinner from this point towards the St. Helen's district. Analyses and laboratory tests show that the coal is of good quality with an ash which is generally low, averaging between 3 and 4 per cent., though occasionally going up to nearly 10 per cent.; volatile matter averages about 40 per cent., and the coal is accordingly used chiefly as a house coal or a gas coal, though its high coking qualities fit it for the manufacture of coke. The report records a complete series of laboratory tests including full analyses, carbonisation assays, investigation of the melting point of the ash, of the caking index, and washing tests, the latter showing that the coal is quite suitable for further cleaning. The report gives evidence of much careful and painstaking work, and there are numerous illustrations; it may be doubted whether the plates showing the cokes produced in the assays are worth the cost involved in their reproduction, and it is also to be regretted that more distinctive colours have not been employed in the map of the Coalfield affixed to the report.

ARTIFICIAL DISINTEGRATION OF ELEMENTS.—In the issue of *Die Naturwissenschaften* of Mar. 23, W. Bothe and H. Fränz have given a short report of some experiments made by them at Berlin, by which they have attempted to decide whether or not the claims of the Viennese school to have effected an extensive disintegration of atomic nuclei by bombardment with α-particles can be substantiated. The source of α-particles employed was a strong preparation of polonium, and since this emits scarcely any β-rays or γ-rays a Geiger electrical counter could be used as a recording instrument in place of a zinc sulphide screen. On the whole, the results obtained confirm the work of Sir Ernest Rutherford and Dr. J. Chadwick. Less than ten per cent. of the retrograde particles from beryllium, carbon, aluminium, and iron recorded at Vienna could be detected, whilst in the forward direction about one H-particle of range greater than 10 cm. in air was found with aluminium and iron, and about ten from paracyanogen and boron, in each case per million α-particles. Boron seems to give two sets of protons, which it is suggested may come from its two isotopic components. It is pointed out that it has not yet been shown that flashes due to β-particles are not detectable with the powerful microscopes now used for viewing scintillations, and that if these are present they will be confused with flashes due to protons, which will thus appear to be present in unduly large numbers.

X-RAY KINEMATOGRAPHY.—The *Chemiker-Zeitung* for Mar. 24 contains a brief description of a new process evolved by Dr. Gottheiner, the Röntgen-ray expert of Berlin, by means of which kinematograph films can be made of objects illuminated by Röntgen-rays. The extreme shortness of the wave-lengths of these rays has hitherto been an insuperable barrier, since they do not converge when passed through lenses of glass or quartz. Thus it has been impossible to obtain reduced images except by re-photographing

life-sized negatives. But by means of suitable screens it is possible to convert these non-converging rays into simple light rays, which can be photographed in the ordinary way on kinematograph films. Dr. Gottheiner has devised screens which give sufficient intensity for the purpose. The process should be extremely valuable in the diagnosis of diseases.

LONG-DISTANCE TELEPHONY IN EUROPE.—At the 'Volta' conference of telegraphists and telephonists, held at Como last September, P. E. Erikson read an interesting paper on long-distance telephony in Europe. In a few years the principal countries in Europe have developed rapidly and methodically methods of communication through underground cables. These now form the main highways of speech. The various countries have all made provision for international circuits. In many cases special mains have been included in the international circuits for the relaying of broadcasting programmes. These additional mains can advantageously be used during the hours when the ordinary traffic is light. They also enable small broadcasting centres to obtain excellent programmes of high artistic merit at a small cost. The cable between Plymouth and Glasgow, a distance of 554 miles, in the longest in Great Britain. There is now a regular service between England, Berlin, and Stockholm. The Paris to Strasbourg cable is destined to play a very important rôle in the future, as it will connect France with central and southern Europe. Paris and Berlin are linked by a cable about 770 miles long, which employs no less than fourteen repeaters. The Berlin-London cable, which was opened in 1926, is the longest through cable (858 miles) in Europe. It is interesting to learn that the London to Glasgow circuit contains some specially loaded cables which are part of the London to New York trans-Atlantic telephone circuit. The thermionic valve repeater has enabled small gauge conductors to be used for long-distance use. Thus many of these circuits are carried within the cable sheath. In addition, the number of communication circuits is appreciably increased by utilising certain of the circuits so as to form 'phantom' circuits. These circuits were first used in the London to Liverpool cable in 1913. To illustrate how rapidly long-distance telephony has advanced, it has been calculated that the total length of 'cable-pairs' in Europe alone would circle the globe sixty-eight times.

VARIATIONS OF RADIO BROADCAST SIGNALS.—Broadcast listeners who are situated between 100 and 150 miles from an emitting station notice that nocturnal variations of signal intensity frequently occur. If a galvanometer instead of a telephone be used, small variations in signal intensity at much shorter distances can be detected. In a paper on signal fading, read to the Institution of Electrical Engineers on April 4 by E. V. Appleton, it is shown by analysing the results obtained at the Peterborough radio research station that the phenomenon of fading is in accordance with the Kennelly-Heaviside layer theory. There are two sets of waves falling on the receiver. One of these is the ground wave and the other is reflected from the ionised layer. During a normal night the height of this layer may vary from 56 to 81 miles. On some nights in winter, however, heights varying from 155 to 217 miles were observed during the three hours before dawn. The author also gives an account of observations taken during the solar eclipse in June 1927. The results prove that the eclipse had a very definite effect on the properties of the ionised layer, which deflected the waves back to the ground. A very striking effect was the large increase in the intensity of the downcoming ray. This effect is ascribed to the increase in height of the deflecting layer and partly also to the rapid removal of the ionisation in the lower layers of the atmosphere consequent on the removal of the solar ionising agents. Another striking feature of the observations was the short time the eclipse effect lasted. The period varied between 20 and 50 minutes at the different stations, while the total time taken for the moon's shadow to pass across the earth was nearly two hours. This means that quite an appreciable fraction of the sun's radiation may be cut off before the effect can be detected by radio methods. The morning after the eclipse happened to be quite exceptional, as night-time conditions persisted for a long time after sunrise. The formulæ given in the paper will be a help to radio engineers.

A NEW ANTISEPTIC SOLUTION.—A new antiseptic solution has been introduced by Messrs. The British Drug Houses Ltd., London, in the form of "Caprokol, antiseptic solution, S.T.37." It is stated that 'Caprokol' lowers the surface tension of liquids in which it is dissolved: this results in increased penetration into the fissures of a surface, especially when the latter is greasy, increased adsorption on to the surface of suspended insoluble material, for example micro-organisms, and an increased rate of diffusion. Hence the antiseptic becomes concentrated round the cell wall of the organism and then penetrates with ease into the cell. 'Caprokol' solution is a solution of 'caprokol' in glycerin and water: its surface tension is 37 dynes per square centimetre, as compared with 77 dynes for water. The carbolic acid coefficient of 'caprokol' is 72: in spite of its strong disinfectant power it is nontoxic. The solution is also non-irritating, odourless, colourless, stainless, and non-corrosive: it is recommended for the disinfection of wounds or tissue surfaces, and for use in the mouth, nose, or throat, or for urethral and pelvic lavage. It is supplied in 3-oz. and 12-oz. bottles.

THE PHOTOCHEMICAL DECOMPOSITION OF NITROUS AND NITRIC OXIDES.—The *Journal of the Chemical Society* for January contains a paper by J. Y. Macdonald describing the results of an investigation of the decomposition of nitrous and nitric oxides by light of wave-length 1860-1990 A. The source of radiation was a condensed spark between aluminium electrodes, and a parallel beam was obtained by using a fluorite lens. Nitrous oxide was found to decompose according to the equation $4N_2O = 2NO + O_2 + 3N_2$, nitrogen peroxide being formed afterwards by the interaction of the nitric oxide and oxygen. The quantum efficiency, that is, the number of molecules decomposed per quantum of radiation absorbed, is 3·9, and appears to be independent of temperature, although the amount of light absorbed, and hence the rate of reaction, varies with temperature. The following mechanism for the reaction is suggested and discussed (N_2O' is an activated molecule):

$$N_2O + h\nu = N_2O'$$
$$N_2O' + N_2O = O_2 + N_2 + 2N$$
$$2(N + N_2O = NO + N_2).$$

In the case of nitric oxide, the quantum efficiency is much lower, about 0·75, and the absorption coefficient is less than that of nitrous oxide. The decomposition appears to take place in two ways according to the equations:

$$2NO = N_2 + O_2$$
$$3NO = N_2O + NO_2,$$

about 90 per cent. of the nitric oxide being decomposed in the first way. Beer's law for the absorption of light holds for both the oxides.

Commercial Shark Fishing.

AN interesting article on a commercial net-fishery for sharks at Port Stephens appears in the *Australian Museum Magazine* (vol. 3, No. 5, Jan.-March 1928). The nets used, each twenty feet in depth, are constructed of forty-two or sixty thread cotton, and are of twelve, sixteen, and twenty inch mesh (six, eight, and ten inch squares). The 'head-line' of the net is buoyed with glass floats, five inches in diameter, every eight feet. The 'ground-rope' is weighted with four-ounce leads every three feet. The nets are set loosely between pairs of buoys and lie vertically on the bottom. They are hauled daily at dawn. Entangled sharks are despatched by heavy blows on the back of the head, or by a revolver bullet through the brain after being initially secured by a large hook thrust through the jaws.

The commercially valuable sharks in their order of prevalence are the whaler (*Carcharhinus macrurus*), grey nurse (*Carcharias arenarius*), tiger shark (*Galeocerdo arcticus*), and white shark (*Carcharodon carcharias*). The largest specimens of these species so far captured vary from 8 ft. to 13 ft. in length and from 370 lb. to 1000 lb. in weight. Species of smaller sharks are actually the more prevalent but are at present discarded.

The daily catches are conveyed to the depot at Pindimar, where cutting up at once begins. First, the fins are removed; these are cut off close to the body and then dried in the sun or in patent hydrators. They are exported to the East for conversion into soup or gelatine. Next the skin in stripped from the carcase. The detached hide is placed on a beaming board, a curved upright iron stand, and the adhering flesh trimmed off with a sharp knife. After trimming is complete, the hide is thoroughly washed with salt water and placed in brine for from twenty-four hours to a week, after which it is stored ready for shipment to the tanners. If the leather is required for other than ornamental purposes, the shagreen must be removed before or during tanning. This is usually accomplished by treatment with hydrochloric acid and salt. Shark leather is very durable and makes an excellent shoe leather. Shark skins with the shagreen left *in situ* are being preserved for ornamental purposes, such as coverings for caskets, trinket boxes, and toilet sets. They may be dyed very beautiful colours. The flesh of the shark is cut into strips a foot long; these are soaked in brine and then hung in dehydrators. When dried it is ready for shipment to the Malay States or Africa, where there is a considerable demand for dried shark flesh for food.

When the hide is being stripped, the abdominal contents are exposed, the most conspicuous feature being the liver. Shark livers are rich in oil, which is extracted in a steam-jacketed kettle of fifty gallons capacity. The best oil producer so far treated is the tiger shark. A thirteen-foot tiger shark yielded eighteen gallons of oil, or at the rate of forty gallons to the ton of shark. Shark liver oil is used for the currying of leather, the tempering of steel, and in soap-making. If extracted from perfectly fresh livers it will probably be used for medical purposes, for it is rich in vitamins A and D.

The brief experience of the Port Stephens Company appears to indicate that catches of sharks are likely to be irregular, at least during some periods of the year. Careful consideration must therefore be given, before embarking on such an industry, to the question whether the profits which accrue from an intensive fishery will compensate for intervening slack periods. Solution of some of the difficulties may be found in the establishment of a depot vessel capable of treating the sharks on board, the catches being supplied by small shark boats fishing in the vicinity. Then, should the shark give out temporarily in one district, the vessel could proceed to other grounds and, if the catches proved to be good, remain there until the depletion of the supply necessitated a further change of ground.

Malay Resins and the Trade.

AN interesting paper, and one of some value on Malayan varnish resins, was recently read before the Royal Society of Arts by Mr. Hedley Barry (*Jour. Roy. Soc. Arts*, Dec. 16), who has carried out considerable investigations into Empire resins. During the past three years the author has been more intimately concerned with the group of Malayan resins. The paper deals with the Malayan varnish resins, with special reference to the work of the Forestry Department of the Federated Malay States and Straits Settlements in the development of the damar industry in the Malay Peninsula.

The Forestry Department, said Mr. Barry, has indeed undertaken a task which all those who have to deal with resins will agree is of the utmost importance. It is endeavouring to supply definite standard grades of the resins found in the forests, the botanical origin of which shall be known, and their freedom from adulteration guaranteed by the Department. This is indeed an ambitious scheme and one of which chemists in particular will cordially approve. The author alludes to some of the difficulties which the Forestry Department—and the remarks are applicable to other Forestry Departments of the British Empire—has to face in carrying out the aims and objects its work entails. In Malaya the rapid development of the tin and rubber industries has been achieved at the expense of an enormous destruction of timber, which is estimated to be of the order of 75,000,000 tons in the last twenty years. At the present time Malaya uses about 5,500,000 tons of timber, of which it produces only about 5,250,000 tons. To produce this amount it is necessary, according to the author, to maintain about 25 per cent. of the country under forest. At present the Forestry Department controls about 19 per cent. of the area, but much of this is not productive land. Its policy is to balance the conflicting demands of the users of forest products and those who require land for rubber planting, tin mining, and similar activities which are making such headway in the Colony. In addition, the maintenance of forests on high land for the protection of cultivated tracts below from the dangers following excessive erosion and the protection of catchment areas requires the careful attention of the forest officer.

In view of these demands on its activities, it is not surprising that it is only within the last few years that the forestry officials have been able to turn their attention to improving the market position of the several valuable resins which the forests produce. The main difficulty which faces the forest officer on such occasions is to get into touch with the trade itself. The forests are situated in far-off tracts of the Empire—almost unknown to the actual users of the raw product—and without some intelligent connecting link little advance can be made, or so the past has

shown on innumerable occasions, in placing a new and perhaps valuable product on the market. As this paper indicates, it is not the forest officer who is often to blame, but the merchant himself at the other end.

It is not possible here to follow the author through his interesting description of the resins and the methods of tapping the trees and so forth dealt with in his paper. The inadequate labour supply forms one of the main difficulties to an increase in output of the resins. At present about 26,000 trees are tapped, but of this number 16,000 are as yet only giving a partial yield, being only tapped up to eight feet instead of the whole height of the stem.

That Mr. Barry's treatment of the subject was that of the expert who is at the same time capable of making his meaning and the interpretation of his work clear to his audience is apparent from the very interesting discussion which followed the paper. An important representative of the trade said that they had learnt a great deal from the lecture. From the trade point of view the Malayan damars are the newest. Of the two Malayan damars the 'cat's eye' (derived from various species of Hopea), from the trade point of view, has the greater value and is pushing the Singapore almost out of use. It is far above the Batavian in value, and is certainly very favourably received by the trade. With regard to black damars, the first sample of black damar received in London came with the useful information that the natives use it to caulk their boats. That is the purpose for which it is usually used in Great Britain, and a huge business has been done in it. The genuine black damar has certainly made its mark. The chairman, Mr. Suter, a leading gum merchant, in winding up the discussion, pointed out the value of the paper with the remark that in the trade they often say, "What can the Government do for us? They simply hinder us: they ask questions and want to know things." Lecturers like Mr. Barry bring it home to the trade that they are mistaken. If they were allied more closely to those in authority, and if they looked to the authorities for more help, they would probably get on quicker than they do.

University and Educational Intelligence.

ABERDEEN.—The King has appointed Prof. J. J. R. MacLeod to be regius professor of physiology in the University in succession to Prof. J. A. MacWilliam, resigned. Prof. MacLeod is at present professor of physiology and director of the Physiological Laboratory of the University of Toronto, and is well known for his work on insulin, for the discovery of which he was awarded, with Dr. F. G. Banting, the Nobel prize for physiology and medicine in 1923.

LONDON.—The following courses of free public lectures are announced: "The Electrical Theory of Molecular Constitution," by Prof. P. Debye, at Birkbeck College, at 5.30, on April 26, 27, and 30; "The Pharmacological Evidence for Current Methods of Treatment," by Dr. J. H. Burn, at University College, at 5, on May 1, 2, and 3; "Anatomy and the Problem of Behaviour," by Dr. G. E. Coghill, at University College, at 5, on May 7, 8, and 10; and "Animal Psychology for Biologists," by Dr. J. A. Bierens de Haan, at King's College, at 5.30, on May 4, 9, and 11.

OXFORD.—Three public lectures of general interest will be delivered during the ensuing term. These are: (1) At 5 P.M. on May 4, "Palæontology and the Origin of Man," by Prof. D. M. S. Watson (Romanes Lecture). (2) At 5.30 P.M. on May 18, "Professions: their Organisation and Place in Society," by Prof. A. M. Carr-Saunders (Herbert Spencer Lecture). (3) At 5 P.M. on June 18, "The Extent and Structure of the Milky Way," by Dr. Harlow Shapley, Director of the Harvard College Observatory (Halley Lecture).

On May 8, alternative schemes for the extension of the Bodleian Library will be considered by congregation.

NOTICE is given that applications for grants from the Dixon Fund for assisting scientific investigations, accompanied by the names and addresses of two references, must be made to the Academic Registrar, University of London, South Kensington, S.W.7, before May 15 next.

APPLICATIONS are invited by the London County Council for two Robert Blair fellowships in applied science and technology, each of the value of £450 and tenable for one year. The fellowships are for advanced study or research in applied science and technology, and will be tenable in the Dominions, the United States, or other foreign countries. Application forms (T.2.a./300) may be obtained from the Education Officer (T.2.a.), The County Hall, S.E.1, to whom the form must be returned by June 18.

APPLICATIONS are invited by the Ministry of Agriculture and Fisheries for research scholarships in agricultural and veterinary science, not exceeding seven in number, each tenable for three years and of the yearly value of £200. Applications must be received (upon form 900/T.G.) by June 15 by the Secretary of the Ministry. The Ministry also invites applications from students who propose to take up posts as agricultural organisers, teachers, or lecturers in agriculture, for not more than five agricultural scholarships tenable for two years and each not exceeding £200 in value per year. The latest date for the return of applications (on form A.189/T.E.) is June 15.

THE Educational Settlements Association's report for 1926–27, published in a recent issue of *The Common Room*, shows that from the income of the year, consisting chiefly of grants from the Joseph Rowntree Charitable Trust (£5350) and the Thomas Wall Trust (£850), grants amounting to £3741 were paid to settlements and colleges. In addition, grants amounting to £735 from the Board of Education were distributed to settlements through the Association. Among the affiliated institutions, now numbering seventeen, are three settlements in London, a college at Surbiton for working women, a college near Evesham for rural workers, two colleges at Birmingham, Coleg Harlech in North Wales, and settlements at Plymouth, Bristol, Letchworth Garden City, Rugby, Leeds, York, Birkenhead, Gateshead, and Lemington-on-the-Tyne. The warden of Coleg Harlech, opened last September as a residential college for adults, contributes an article in which he calls it "a symptom of a universal tendency which owes its origin primarily to Denmark." Its teaching is to be characterised by attention to the needs of students individually; formal lectures are dispensed with, and, as in the Danish Folk High Schools, no encouragement is given to students to leave their former occupations. Intercourse with foreign countries is a noticeable feature of the work of several of the settlements. Thus, Avoncroft reports that Scotland, Holland, Denmark, and Germany are represented among its students; the Gateshead settlement entertained visitors from Germany and Czechoslovakia; Bristol Folk-house organised a Rhine tour, and Letchworth an Italian tour.

Calendar of Customs and Festivals.

April 23.

ST. GEORGE, Patron Saint of England. Martyr under Diocletian, A.D. 285. Notwithstanding his widespread fame, nothing authentic is known of his life. According to the generally accepted version he was born in Cappadocia, son of a martyred father, served with distinction in the army, and, inheriting a great fortune on the death of his mother, declared himself a Christian before the Emperor, and was martyred with many miraculous incidents. According to Ammianus Marcellinus, however, he was born in Cilicia, and it is said that he acquired a fortune at Constantinople as a purveyor of bacon to the army by anything but honest means. On being found out, he fled to Cappadocia, where he professed Arianism and was promoted to the throne of St. Athanasius. As primate of Egypt he behaved with pride and insolence, while plundering the rich temples of the pagans. This led to his martyrdom at the hands of the heathen, but the date, A.D. 361, points to a confusion of two different personalities.

A mass of legend was incorporated in the lives of St. George, and he became one of the Seven Champions of Christendom. The story most familiar is that of the slaying of the dragon and the rescue of the princess, an incident which is said to have taken place at Silene in Libya. This story was accepted without question in orthodox belief of the Middle Ages; but was excised by Clement VII. It belongs to a group of legends of which the story of Perseus, the Minotaur, Fafnir, and the various 'worms' of English ballad are typical examples. This attained a great vogue in the medieval church from the identification of the dragon or snake with the devil.

St. George is a prominent figure among the saints of most, if not all, European countries. He became the patron saint of England under the early Norman kings, and was made the Saint of the Order of the Garter when it was founded by Edward III. It is, however, in the Mediterranean and in Russia and eastern Europe under the Greek Church that St. George is especially prominent. Among the peasantry of Greece and the Balkans, April is known as the month of St. George. He is the object of a cult of the gypsies of the East as their patron saint. They also, it may be noted, are specially connected with the snake, of which they are reputed to be skilled charmers.

Throughout the Mediterranean the feast of St. George has taken the place of a pastoral festival known to us principally through the *Parilia* of Rome, which took place on April 21, the traditional date of the birth of Numa. On that day the flocks and herds were purified, preparatory to driving them out to their summer pasturage. Fires were lit, the flocks were fumigated, or driven through the fires, over which the shepherds jumped, and offerings of milk and millet were made to Pales. This pastoral ceremony corresponded to the *Fordicidia* of April 15, an agricultural ceremony in which a pregnant cow was sacrificed to the earth goddess Tellus, and the ashes of her unborn calf, mixed with the blood of a horse and bean stalks, were preserved to be used by the senior Vestal Virgin to purify the people six days later at the shepherds' festival of *Parilia*.

April 24.

HOKE OR HOCK DAY. HOCK TIDE.—An English popular festival of which the name appears in writers so early as the thirteenth century. At one time it was generally observed, but after the Reformation it gradually died out. The principal day of Hock Tide was the Tuesday after the second Sunday following Easter, when the women hocked the men, the men hocking the women on the preceding day, though in some localities the procedure was reversed. An alternative name, Binding Tuesday, indicates the nature of the custom. Women stopped the way with ropes and, pulling passers-by to them, released them only on payment of a fine. The proceeds, which were usually more considerable on the women's day, were devoted to the renovation of the parish church. The performance was accompanied by a good deal of merrymaking, and, according to one account, beating of brass instruments and singing old rhymes. Traditionally the festival was connected with a defeat of the Danes—according to one version, on St. Brice's day (Nov. 13) 1002. A Hock Tuesday play, acted before Queen Elizabeth at Kenilworth in 1575, represented this action, in which the Danes were shown to be finally defeated by the help of the Saxon women—clearly a popular explanation of the peculiar position accorded to the women by the custom.

Rents were sometimes payable on Hoke day, and at Hungerford, Hock Tide customs were observed in connexion with the tenure of rights over lands bequeathed to the town by John of Gaunt. These facts, like hirings and leasings at other times, point to it being a traditional termination of an annual period. This view is further supported by the resemblance of hocking to the Easter inter-sexual customs such as 'lifting,' buckle stealing, and the observance by which the men beat their wives on the Tuesday in Easter week, but the women beat the men on the following day.

April 25.

ST. MARK'S DAY.—On the eve of St. Mark's day, ashes were riddled on the hearth. If any in the house were predestined to die within the year, a shoe would appear impressed in the ashes. A similar forecast was obtained in Yorkshire by watching in the church porch from eleven until one o'clock. When this has been done three years in succession, the ghosts of all who would die within the next year passed into the church, infants and young children rolling along the pavement. In Northumberland a practice similar to those of St. Agnes' eve was observed. Parties of girls, never more than three, baked a 'dumb cake,' made in silence and eaten at twelve o'clock, when the members of the party each retired to bed backwards. Those who are to be married see their sweethearts hurrying after them; or they may hear a knocking at the door or a rustling. Another ceremony with the same object is to eat the yolk of an egg in silence, filling its place with salt.

April 27.

From April 27 until May 3 (O.S.) is known in Morocco as *n-nisän*—a propitious period when everyone is happy. The rain is considered highly beneficial, alike to men, animals, and crops. Owing to its powers it is collected and used for a variety of magical purposes. It will prevent snakes and scorpions from biting if kept in the house, will cure headache, and will increase the butter-yielding qualities of milk. But it must not touch the earth, be exposed to the sun, or be breathed upon. It is used as a fertility charm by women, and it protects grain from the evil eye. Similar beliefs relating to this period are recorded from Palestine. In the Highlands of Scotland the period of fourteen days before May Day is known as the 'balk or ridge of Beltane.'

Societies and Academies.

LONDON.

Mineralogical Society, Mar. 20.—**A. F. Hallimond**: On the atomic volume relations in certain isomorphous series (2). The volume relations of compounds of calcium, strontium, barium, with oxygen, sulphur, selenium, and tellurium correspond in every way with those previously indicated for potassium, rubidium, cæsium, sodium, lithium, and the halogens. The difference in the volume produced by the interchange of eutropic elements exhibits a constant ratio in each series. The partial volumes calculated for the radicles from the volumes of the free metals agree with those already obtained for the alkali compounds, and the values for oxygen and fluorine agree with those calculated by Wasastjerna from the refractive indices. The volume effect of substitution in the sodium chloride lattice varies somewhat with the size of the cell, but the variation never attains the extent required for a law of constant radii. Other isomorphous series agree with the Law of Retgers, and the present results are therefore expressed in terms of a law of additive volumes rather than additive radii.—**A. Holmes and H. F. Harwood**: On the age and composition of the Whin Sill and the related dikes of the north of England. The rocks of the Whin Sill and its associated dikes are quartz-dolerites of substantially identical composition. Dikes of this series run north of east. They are quite distinct from the system of tholeiite dikes to which the Bingfield dike, the 'Brunton type' of Teall, belongs. A pebble of quartz-dolerite in the Upper Brockram of George Gill, Brackenber Moor, near Appleby, has been proved by chemical analysis to be definitely of the Whin Sill type. This, with other evidence, indicates that the age of Whin Sill and its associated dikes is post-Westphalian and pre-Upper Brockram.—**A. W. Groves**: The identification of dumortierite in grains: dumortierite in Cornish granite. Dumortierite may be confused with a number of more common minerals. It is recorded in several sediments in southern England and in the Land's End granite.—**T. V. M. Rao**: On 'bauxite' from Kashmir, India. The so-called bauxite of Kashmir consists mainly of diaspore and an opaque mineral corresponding in composition to a monohydrate of alumina. The deposit was derived from beds of clay, having been first altered into the dihydrate (bauxite) and afterwards to its present condition through dehydration and thermodynamic metamorphism.

Linnean Society, Mar. 29.—**Malcolm Wilson and Miss M. J. F. Wilson**: The Dutch elm disease and its occurrence in England. The Dutch elm disease was discovered in Holland in 1919, and during the same year in the north of France. The following year it was reported from all parts of Holland, and in 1921 was stated to be present throughout Belgium. In the same year it was recorded from western Germany, and since that date has spread over the greater part of that country. An outbreak of the disease was discovered near London last July. Three explanations have been offered as the cause of the epidemic: (1) The fungus *Graphium Ulmi* Schwarz; (2) *Micrococcus Ulmi* Brussoff; (3) unfavourable climatic conditions, *i.e.* drought and frost. The first explanation is generally accepted by the Dutch investigators. The disease may be readily recognised by the yellow discoloration of the leaves in the crown of the tree or at the tips of the side branches. This condition usually spreads rapidly over the tree, and is followed by leaf-fall and by the death of the tree. Defoliation may be complete within a week, but sometimes extends over a much longer period. Infected branches, when cut across, show one or more rings of small brown spots in the most recently formed wood. These internal symptoms sometimes, but not invariably, can be found in the roots. The disease is present in epidemic form throughout most of western Europe, and shows no sign of becoming less virulent. No species of Ulmus grown in Holland appears to be immune, and no adequate method of control has yet been discovered.—**R. W. Butcher and F. T. K. Pentelow**: The effect of pollution on the ecology of a small stream. An ecological study has been made during the past two years of the River Lark in West Suffolk. From September to February a beet-sugar factory empties into the river about four million gallons of waste waters a day. This water contains much organic matter and so deoxygenates the river-water; *e.g.* at one station the oxygen fell from 110 per cent. to 19 per cent. saturation. There is also an increase in the ammoniacal nitrogen. The effect on the flora is to increase the number of bacteria and cause very large growths of 'sewage fungus,' of which *Sphærotilus natans* is the commonest. The fauna of the river may be divided into three definite ecological associations dependent on the oxygen present—the Gammarus type occurring everywhere among the weeds and among stones and gravel on the bottom, the Sialis-Sphærium type occurring on the bottom in muddy stretches, and the Chironomid-Tubificid type which occurs in very foul mud. The effect of pollution is due to the reduction of oxygen, and results in the encouragement of Sialis-Sphærium and Chironomid-Tubificid associations at the expense of the Gammarus type.

Society of Public Analysts, April 4.—**John Evans and T. E. Wallis**: Coffee parchment as an adulterant of bran and sharps. The 'parchment' consists of the thin and tough endocarp of the coffee fruit, and may be recognised by its distinctive cellular structure. When added to sharps it is usually finely comminuted, and in testing a sample a few of the suspicious pieces should be boiled with chloral hydrate solution until transparent, and a fragment mounted in chloral hydrate for microscopical examination.—**W. B. Adam**: Determination of the colour-producing constituents of the cacao bean. The two principal colour-producing constituents are cacao catechin and cacao tannin. The former has been extracted with ether and determined colorimetrically by means of Mitchell's ferrous tartrate reagent, whilst the latter is extracted with hot water and determined by precipitation as cinchonine tannate. The catechin is destroyed during fermentation, and the tannin is reduced to about 2 per cent.—**A. T. Etheridge**: Determination of vanadium in steel. The method consists in removing iron (as chloride by extraction with ether) and other interfering metals, by electrolysis over a mercury cathode, leaving a solution in which the vanadium can be determined by titration with permanganate. The process is accurate for all kinds of steels. In the case of molybdenum steels the molybdenum is removed together with the ferric chloride on extraction with ether. Manganese, like aluminium, has no influence on the final permanganate titration.—**S. G. Clarke**: Colorimetric determination of small quantities of antimony and their separation from tin. The antimony is deposited on metallic copper as in the Reinsch method, the deposited film stripped off by means of sodium peroxide, and the antimony determined colorimetrically. The method is applicable to antimony in either state of oxidation, and in the presence of tin or arsenic, but bismuth and several

of the other heavy metals give precipitates, usually coloured, with the reagents.—**A. Riad**: Determination of carbon dioxide in soils. Hepburn's modification of the Van Slyke method of determining carbon dioxide in carbonates (in which the evolved gas is absorbed in standard baryta solution, the excess of which is titrated with oxalic acid) has been adapted to the determination of carbon dioxide in soils. The method is suitable for general soil analysis.

PARIS.

Academy of Sciences, Mar. 12.—The president announced the death of M. Guignard.—**E. Gourat**: Some singular lines of surfaces admitting a given linear element.—**E. Mathias**: Magnetic measurements in the Haute-Marne, Côte-d'Or, and Aube. An account of work done in 1924 at forty-two stations, twenty-three of which are new.—**Georges de Rham**: Duality in *analysis situs*.—**Paul Montel**: Continued functions of a real variable, which admit a theorem of algebraic addition.—**Paul Lévy**: An asymptotic point of view in the study of ensembles of points on a right line.—**N. Saltykow**: The integration of partial differential equations by separation of the variables.—**Alfred Rosenblatt**: Certain stationary movements of incompressible viscous liquids.—**S. de Glasenapp**: Personal equations in the micrometric measurement of double stars. The method suggested is the comparison of the results of observation with the values, assumed to be known exactly, of the angles of position θ_0 and distances ρ_0 for a certain number of comparison stars, such that the relative displacement of the components is negligible. To facilitate the application of the method a list of comparison stars is given, uniformly distributed over the sky, with varied angles of position and distances ρ less than $3''$.—**Mme. E. Chandon**: The tides of the Red Sea. Correction of an error in the calculations of A. Blondel. The differences between the observed and calculated values do not exceed 2 cm., and it is concluded that friction does not have any appreciable effect on tides in the Red Sea.—**A. Lambert**: The velocity of propagation of radiotelegraphic waves. The velocity as determined by recent experiments would appear to be appreciably lower than 300,000 km. per second, the mean result being 247,000 km./sec. ± 9000.—**Canaud**: The electrolysis of water by an alternating current. If the water is allowed to reach its boiling-point some hydrogen is evolved at a regular rate, in amount corresponding to about $\frac{1}{350}$ of that which would have been produced by the corresponding continuous current. Iron electrodes were employed.—**Svend Aage Schou**: The absorption spectrum of formaldehyde in solution. Previous work has proved that aqueous solutions of formaldehyde contain only the polymerised form. The monomolecular aldehyde in hexane at − 70° C. gives a spectrum with at least 17 bands between 3542 and 2750 A., the positions of which are given.—**A. Boutaric** and **Mlle. G. Perreau**: The determination of dilute saline solutions by the opacity of fine suspensions obtained starting with these solutions. An account of attempts to stabilise precipitates, such as silver chloride, by the addition of various colloids.—**J. Huggett** and **G. Chaudron**: The thermomagnetic study of some iron minerals.—**P. Nicolau**: Annealing anomaly of copper and brasses after hammer hardening.—**L. Bert**: A new general synthetic method for preparing arylaliphatic aldehydes. In a previous communication the author has given a method for preparing the chlorides $RC_6H_4(CH_2)_nCl$. The magnesium compounds prepared from these condensed with methyl orthoformate give good yields of the acetals of the aldehydes $RC_6H_5(CH_2)_nCHO$, from which the corresponding aldehydes are readily obtained by hydrolysis with hydrochloric acid. Details of new aldehydes prepared by this method are given.—**Albert Kirrmann**: The action of amines on bromo-œnanthol.—**Vavon** and **V. M. Mitchovitch**: The *o*-cyclohexylcyclohexanols.—**R. Locquin** and **R. Heilmann**: The separation of the stereoisomeric unsaturated ketones.—**L. Neltner**: The geology of the Goundafi country (Morocco Haut Atlas).—**J. Repelin**: The Aquitaine basin at the Helvetian epoch: the marine gulf.—**G. Mangenot**: The cytological localisation of the peroxydases and the oxydases.—**Tsen-Cheng**: The phenomena of necrosis in potato disease. The necrosis of the diseased potato is in most cases only an exaggeration of the normal destruction of the sieve tubes accompanied by defensive reactions on the part of the neighbouring cells.—**Auguste Lumière** and **Mme. R. H. Grange**: The comparative toxicities of sera arising from venous blood and blood from the umbilical cord.—**Henri Pottevin** and **Robert Faillie**: The variation of the visual psychomotor reaction as a function of the lighting.—**Jean Verge** and **Edmond Grasset**: Researches on the microbial flora of frozen eggs. Amongst the organisms found in Chinese eggs were some belonging to the paratyphic and coli groups, which might possibly give rise to toxic infections. The eggs should be sterilised by heat during preparation as food.

GENEVA.

Society of Physics and Natural History, Feb. 16.—**F. Chodat**: The specificity of Stichococcus, more particularly from the soil of the [Swiss] National Park. The author communicates the results of his tests for Algæ in the soils of the National Park and presents a first series of pure cultures belonging to the genus Stichococcus.—**Amé Pictet** and **H. Vogel**: The synthesis of cane sugar. When fructose is treated with acetic anhydride, it forms a normal tetracetate and an isomer. An equimolecular mixture of these two substances, suitably treated, leads to the synthesis of cane sugar.—**O. Jaag**: New researches on the gonidia of lichens. These researches lead to the proof, for the two varieties of the lichen studied (*Parmelia caperata*), of the formation of gametes, a new fact for algæ of lichen symbiosis, and also to the existence of zoospores different from those already described.—**F. Wyss-Chodat**: The transmissibility to the animal of the parasite of fungoid mycosis. The author has studied a fungus isolated from the skin and from the ganglion of a subject attacked with fungoid mycosis. From the observations it must be admitted that this is a parasitic disease. The inoculation of mice has given results confirming this hypothesis.—**R. Wavre**: Figures of equilibrium of a heterogenous fluid mass. The author brings forward some results new to the solution of this problem of rational mechanics. These results, which are unsuitable for abstraction, lead to important modifications of the laws of rotation of planets in the fluid state.—**M. Gysin**: The application of the methods of Fedorow to the identification of microcline without macles. The author's researches allow of the identification of the mineral in gneiss and prevent the confusion frequently made between microcline and orthose.

Mar. 1.—**G. Déjardin**: (1) Recent spectroscopic applications of the electrodeless discharge. Experiments made on different substances, phosphorus in particular, show that the spectra characteristic of different degrees of ionisation may be separated by utilising the electrodeless discharge to produce them. (2) The filtration of the solar radiation by ozone.

(Observations carried out at the Mont Blanc Observatory, from 1923 to 1926, in collaboration with Lambert and Chalonge.) These experiments show that for each zenithal distance of the sun the curve representing the variations in absorption as a function of the wave-length reproduces perfectly, in certain regions of the spectrum, all the known details of the absorption curve of ozone. From this it is deduced that the ozone should be found localised, for the greater part, in a zone situated about 45 kilometres above the earth.

ROME.

Royal National Academy of the Lincei, Jan. 8.—**F. Severi**: Simple and double algebraic integrals (1 and 2).—**G. Fubini**: A new generation of Darboux's quadratics.—**U. Cisotti**: An exception to Kutta-Joukowski's theorem.—**N. Parravano** and **G. Malquori**: Molybdenum sulphides. (1) Tensions of the sulphur of molybdenum trisulphide. The logarithm of the tension of the sulphur of molybdenum trisulphide is a linear function of the temperature, the emission of the sulphur vapour being irreversible.—**P. Vinassa de Regny**: The geochemical inertia of the triad elements. As a general rule, both simple and compound substances, whether natural or artificial, organic or inorganic, have even molecular numbers. Almost the whole of the earth's mass is composed of substances with atomic numbers below 28, that is, those of the first triad. The geochemical inertia of the elements of the triads may be related to the number and disposition of the electrons corresponding with a condition of equilibrium.—**S. Franchi**: The series of rocks from the Priabonian to the Noric in the neighbourhood of Albenga.—**L. A. Herrera**: Artificial albuminoid cells. Imitations of the natural cells of organisms may be made with the help of egg albumin.—**S. Minetti**: The necessary and sufficient conditions that an entire function may be of a certain genus and of a certain order.—**Rosalind Cecily Young**: The values of the integral $\int_a^b f(x)dg(x)$ of a function $f(x)$ with a non-integrable point, in relation to $g(x)$.—**V. Hlavatý**: Linear differential systems with an indefinite quadratic integral.—**E. Pistolesi**: A supposed exception to Kutta-Joukowski's theorem. Investigation of the problem of a plane strip in an indefinite current, with circuitation different from zero, regarded by Cisotti as an exception to Kutta-Joukowski's theorem, shows that this is not the case, and places beyond doubt the quite general character of the theorem.—**M. Maggini**: The effective wave-length of [radiation from the] stars and a method of determining it by means of the interferometer.—**G. Andrissi**: The absorption of stellar light in the atmosphere of Rome.—**M. Bossolasco**: Plasticity in the phenomena of orogenesis.—**U. Panichi**: Diabases and melanocratic veinous rocks of Sardinia.—**G. Quagliariello**: Action of cold on the fats of milk. The lowering of the surface tension of milk cooled below 10° C. is dependent on the passage of triglycerides of the lower fatty acids from the globules into the interglobular liquid, in which they dissolve.—**G. Martino**: Different contents in 'phosphogen' of striated muscle under rapid and under torpid contraction.—**G. Brunelli**: Anatomico-physiological investigations on the significance of the intrahepatic pancreas in the Teleostei.—**G. Brunelli** and **G. Fasella**: A very rare cetacean on the coast at Nettuno. A cetacean, stranded near Foco Verde in Nettuno in November last, belongs to the genus Mesoplodon and is probably *M. bidens*.—**R. Savelli**: Giant seeds and a case of poly-endospermia due to extraneous pollination on *Nicotiana rustica*.—**E. Francini**: Phenomena of somatic asporia, gonial asporia, and adventitious embryony in *Ochna multiflora*.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, Vol. 14, No. 1, January).—**Raymond Pearl, Agnes Allen Winsor**, and **John Rice Miner**: The growth of seedlings of the cantaloup, *Cucumis melo*, in the absence of exogenous food and light. The growth in length of cantaloup seedlings grown in the dark on a sterilised medium and supplied only with sterilised water, with or without fresh supplies of sterilised air, follows a logistic curve essentially the same as that for normal growth.—**David White**: Some factors in rock metamorphism. The progressive transformation of carbonaceous sediments can be used as a scale for the determination of the stages of incipient metamorphism. Carbonisation is the result mainly of horizontal thrust, temperature, and time, of which the former is of pre-eminent importance. Vertical pressure is relatively insignificant in effect; it assists the strata to resist buckling and helps to raise the temperature. The time factor only becomes important in the presence of advanced pressures and their consequent temperatures.—**D. F. Hewett**: Late Tertiary thrust faults in the Mojave Desert, California. The Spring Mountains and adjacent ranges contain at least six extensive overthrust faults and numerous minor thrusts as well as normal faults. They dip westward at angles of 5°-45°, and rocks ranging from pre-Cambrian granite gneiss to Pennsylvanian limestones are thrust generally eastward upon younger rocks ranging from lower Palæozoic to Jurassic. The thrust faults seem to have been formed in early Eocene times.—**Raymond T. Birge**: The quantum levels and resulting constants of the hydrogen molecule (*v.* NATURE, Jan. 28, p. 134).—**Charles S. Barrett**: The scattering of X-rays from gases. Filters of strontium oxide and zirconium oxide, each adjusted to absorb 50 per cent. of molybdenum $K\beta$ radiation, are well matched at all wave-lengths except between their K absorption limits; the two thus give practically monochromatic radiation (Prof. P. A. Ross). Such a beam is passed through a gas chamber and into an ionisation chamber. It is concluded that interference occurs in X-rays scattered from a single molecule of carbon dioxide or oxygen, and is absent in rays scattered from a hydrogen molecule (between 30° and 90°).—**Louis S. Kassel**: The distribution of energy in molecules. In a group of oscillators in statistical equilibrium, some classical and some quantum, the latter all having the same frequency, the chance that a given classical oscillator shall have energy equal to or greater than m quanta is exactly the same as the chance that a given quantum oscillator shall have m or more quanta.—**I. S. Bowen**: The life of atomic states and the intensity of spectral lines. The origin of the strong nebular spectral lines in electron jumps from metastable states in oxygen and nitrogen is evidence that metastable states are states of long mean life and not absolutely metastable. If the ratio of the mean time between collisions of the second kind to the mean life of the state before spontaneous emission is small, the majority of the atoms are taken out of the excited state by collisions of the second kind and the line is weak; if the ratio is large (as it is under nebular conditions) the atoms can radiate spontaneously and the line appears strongly. This explanation is applicable to other anomalous line intensities and suggests a gradation of mean lives from 10^{-8} sec. (normal lines) to 1 sec. or more (nebular lines).—**R. J. Lang**: The spectra of singly and doubly ionised

germanium (Ge II and III).—**Jared Kirtland Morse**: (1) The structure and dimensions of the ethane molecule. A scale model is built up, using the cubic lattice already employed in discussing the crystal lattices of diamond and graphite. (2) The lattice structure of ethane. The model constructed would cause diffraction effects agreeing well with Mark and Pohland's results for solid ethane, except in regard to the 004 plane.—**R. A. Millikan** and **C. C. Lauritsen**: Relations of field-currents to thermionic-currents. It has been shown by Millikan and Eyring that in the extraction of electrons from metals, the electrons constituting the field current are not identical with the thermions and, over a range of 700° C., are independent of temperature. The data used, and also new data, give curves for the relationship between $\log i$ (i = field current) and $1/F$ (F = applied field) which are straight lines. At sufficiently high temperatures the thermionic- and field-currents are not independent. A combined formula is obtained showing that the application of an external field is equivalent to increasing the temperature of the electrons within the metal.—**Gregory Paul Baxter** and **Howard Warner Starkweather**: (1) The density, compressibility, and atomic weight of neon. In purification, the gas was absorbed on chabazite cooled with liquid oxygen or nitrogen. The density and atomic weight found are 0·89990 and 20·182 respectively. (2) The density, compressibility, and atomic weight of argon. The normal density is 1·78364, the limiting density is 1·78204, and the atomic weight 39·943. These values assume that the conventional method of calculating the deviations from Boyle's law is correct; a more rigorous investigation, however, only makes a difference of so much as 0·00001 in a few of the results.—**A. M. Showalter**: The chromosomes of *Pellia Neesiana*. The male and female plants contain nine chromosomes. One of those of the female seems to be an X-chromosome; in the growing regions, it remains condensed throughout the interphases, recalling the behaviour of sex chromosomes from spermatogonia of animals.—**T. H. Goodspeed** and **A. R. Olson**: The production of variation in Nicotiana species by X-ray treatment of sex cells. Mature plants bearing flower buds were subjected to X-ray bombardment for 10 min. or 20 min. Their seed gave more than 20 per cent of morphologically abnormal plants, but only rarely were the variants completely sterile. Similar effects are obtained if only the male sex cells are irradiated. Cytological examination of the variants shows that, in some of them, one of the meiotic chromosomes has an appendage similar to that born by many somatic chromosomes.—**L. J. Stadler**: Genetic effects of X-rays in maize. Heavy treatment reduces considerably the yield and viability of pollen, but seems to have no effect on crossing-over in a particular region of the chromosome; it does increase, however, the percentage of seed with mosaic endosperm when crosses of an endosperm dominant with an endosperm recessive are used.—**Edward Kasner**: General theory of polygenic or non-monogenic functions. The derivative congruence of circles.—**G. A. Miller**: Number of systems of imprimivity of transitive substitution groups.—**R. L. Moore**: Concerning triods in the plane and the junction points of plane continua.—**Cecilia H. Payne** and **Frank S. Hogg**: On methods and applications in spectrophotometry. The work being carried out at Harvard in this field is described and discussed. It should result in placing several qualitative astrophysical arguments on a quantitative basis.—**Willard Owen Thompson**, **Phebe K. Thompson**, and **Mary Elizabeth Dailey**: The effect of posture upon the composition and volume of the blood in man. In standing still, the blood suffers a net loss of about 11 per cent. of the total plasma volume of approximately protein-free fluid, due to increase in capillary pressure. The loss, which occurs in 20-30 min. and is recovered in a similar time on lying down, is greatest at the extremities.—**Alfred J. Lotka**: Sterility in American marriages. Using the data for 1920 of the United States Census Bureau, it is calculated that the effective sterility of American (white) wives is 17·1 per cent. Of this total, 1·2 per cent. is due to premature death of wives, 2·0 per cent. to premature death of husbands, and 0·8 to divorces. The net sterility of American (white) wives is thus 13·1 per cent.—**Louis Harris**: The photochemical union of hydrogen and chlorine. The apparatus was entirely of quartz and the reaction vessel was illuminated with light of wave-length greater than 4050 A. A thermopile behind the reaction tube measured the energy available. The final hydrogen pressure was measured after freezing out the hydrogen chloride formed and the unchanged chlorine. The minimum yield with excess of hydrogen was 6×10^5 molecules of hydrogen chloride per quantum of light.

Official Publications Received.

BRITISH.

Government of Bengal: Irrigation Department. Report on Rainfall and Floods in North Bengal, 1870–1922. By Prof. P. C. Mahalanobis. Pp. v+90+32 maps. (Calcutta: Bengal Secretariat Book Depot.) 20 rupees; 30*s*.

The National Benzole Association. Fifth Report of the Joint Benzole Research Committee of the National Benzole Association and the University of Leeds. (Presented March 21st, 1928.) Pp. iv+237 (London: National Benzole Association.)

Colony of the Gambia. The Annual Report of the Department of Agriculture for the Period January 1st, 1926, to March 31st, 1927. Pp. 53. (London: The Crown Agents for the Colonies.) 5*s*.

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, Dominica, 1926–27. Pp. iv+41. (Trinidad, B.W.I.) 6*d*.

The Journal of the East Africa and Uganda Natural History Society. No. 30, July 1927. Pp. 55-110+25 plates. (Nairobi.) 5*s*.; to non-Members, 10*s*.

Report of the Felsted School Scientific Society for the Years 1926 and 1927. (No. 30.) Pp. 40. (Felsted.)

Papers and Proceedings of the Royal Society of Tasmania for the Year 1927. Pp. vi+237+28 plates. (Hobart: The Tasmanian Museum.) 10*s*.

Ceylon Journal of Science. Section B: Zoology and Geology. Spolia Zeylanica. Edited by Dr. Joseph Pearson. Vol. 14, Part 2, March 12th. Pp. 135-349. (Colombo: Colombo Museum; London: Dulau and Co., Ltd.) 3 rupees.

Rhodesia Museum, Bulawayo. Twenty-sixth Annual Report, 1927. Pp 12. (Bulawayo.)

Proceedings of the Society for Psychical Research. Part 105, Vol. 38, April. Pp. 16. (London: Francis Edwards, Ltd.) 1*s*. 6*d*.

Agricultural Research Institute, Pusa. Bulletin No. 171: The Improvement of Indian Wheat; a Brief Summary of the Investigations carried out at Pusa from 1905 to 1924, including an Account of the new Pusa Hybrids. By Albert Howard and Gabrielle L. C. Howard. Pp. v+26. (Calcutta: Government of India Central Publication Branch.) 8 annas; 10*d*.

Supplement to *The Journal of Ecology*. 1, February. British Empire Vegetation Abstracts: Titles and Abstracts of Publications on the Vegetation and Ecology of the Overseas Empire and on related Topics. Pp. 20. (Kew, Surrey: British Empire Vegetation Committee; Hon. Secretary: Dr. T. F. Chipp, 199 Kew Road.) Subscription price, 5*s*. a year.

Transactions of the Optical Society. Vol. 29, No. 2, 1927–28. Pp. 49-100. (London.) 10*s*.

Board of Education. Educational Pamphlet, No. 57: Memorandum on the Teaching of Building Science to Students attending Courses of Instruction in Building and the Building Trades. Pp. 16. (London: H.M. Stationery Office.) 3*d*. net.

University Grants Committee. Returns from Universities and University Colleges in receipt of Treasury Grant, 1926–1927. Pp. 24. (London: H.M. Stationery Office.) 3*s*. net.

Apia Observatory, Apia, Western Samoa. Report for 1925. Pp. 95+3 plates. (Wellington, N.Z.: W. A. G. Skinner.)

Reports of the Council and Auditors of the Zoological Society of London, for the Year 1927, prepared for the Annual General Meeting to be held on Monday, April 30th, 1928, at 4 p.m. Pp. 91. (London.)

FOREIGN.

Department of the Interior: Bureau of Education. Bulletin, 1927, No. 19: State Laws and Regulations governing Teachers' Certificates. By Katherine M. Cook. Pp. v+296. 40 cents. Bulletin, 1927, No. 33: Statistics of Public High Schools, 1925–1926. Pp. 92. 10 cents. Bulletin, 1928, No. 1: Educational Directory, 1928. Pp. iii+144. 20 cents. (Washington, D.C.: Government Printing Office.)

Conseil Permanent International pour l'Exploration de la Mer, Journal du Conseil. Rédigé par E. S. Russell. Vol. 3, No. 1, Avril. Pp. 131. (Copenhague: Andr. Fred. Høst et fils.) 4.50 kr.

Peking Society of Natural History. Bulletin, Vol. 1, Parts 2 and 3: Chinese Birds, by Wilder, Gee and Moffett; and Yearly Proceedings with Reports. Pp. ix-xii+145-370+8. (Peking.)

Regenwaarnemingen in Nederlandsch-Indië. Acht en veertigste Jaargang, 1926. Pp. ii+133. (Weltevreden: Landsdrukkerij.)

The Eugenical Aspects of Deportation. Hearings before the Committee on Immigration and Naturalization, House of Representatives. Seventieth Congress, First Session, February 21, 1928 (including Testimony taken April 28, 1926, with eight Appendices). Statement of Dr. Harry H. Laughlin. Pp. ii+84. (Washington, D.C.: Government Printing Office.)

Ministry of Finance, Egypt: Coastguards and Fisheries Service. Report on the Fisheries of Egypt for the Year 1926. By El Miralai Ahmed Fouad Bey. Translated from the Arabic by Selim Eff. Khoury. Pp. x+91. (Cairo: Government Publications Office.) 5 P.T.

Smithsonian Miscellaneous Collections. Vol. 80, No. 7: The Aboriginal Population of America North of Mexico. By James Mooney. (Publication 2955.) Pp. 40. (Washington, D.C.: Smithsonian Institution.)

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium, Vol. 27: Flora of the Panama Canal Zone. By Paul C. Standley. Pp. x+416+67 plates. (Washington, D.C.: Government Printing Office.) 75 cents.

Smithsonian Institution: United States National Museum. Bulletin 142: Life Histories of North American Shore Birds. Order Limicolae (Part 1). By Arthur Cleveland Bent. Pp. ix+420+55 plates. (Washington, D.C.: Government Printing Office.) 85 cents.

Department of the Interior: U.S. Geological Survey. Professional Paper 150-C: A Section of the Kaibab Limestone in Kaibab Gulch, Utah. By L. F. Noble. (Shorter Contributions to General Geology, 1927.) Pp. ii+41-60+plates 12-14. Bulletin 795-G: Phosphate Rock in the Three Forks-Yellowstone Park Region, Montana. By D. Dale Condit, E. H. Finch and J. T. Pardee. (Contributions to Economic Geology, 1927. Part 1.) Pp. iv+147-209+plates 10-12. Bulletin 795-H: A Manganese Deposit of Pleistocene Age in Bannock County, Idaho. By D. F. Hewett. (Contributions to Economic Geology, 1927, Part 1.) Pp. ii+211-221. Bulletin 796-C: Geology and Coal Resources of the Salina Canyon District, Sevier County, Utah. By Edmund M. Spieker and Arthur A. Baker. (Contributions to Economic Geology, 1927, Part 2.) Pp. iv+125-170+plates 19-22. 15 cents. Bulletin 796-D: Geology and Oil and Gas Possibilities of the Bell Springs District, Carbon County, Wyoming. By C. E. Dobbin, H. W. Hoots and C. H. Dane. (Contributions to Economic Geology, 1927, Part 2.) Pp. iv+171-201+plates 23-27. (Washington, D.C.: Government Printing Office.)

Bulletin of the Bingham Oceanographic Collection. Scientific Results of the First Oceanographic Expedition of the *Pawnee*, 1925. Vol. 1, Art. 3: Mollusca from Tropical East American Seas. By Lee Boone. Pp. 20. Vol. 1, Art. 4: Echinodermata from Tropical East American Seas. By Lee Boone. Pp. 22+8 plates. Vol. 1, Art. 5: Coelenterata from Tropical East American Seas. By Lee Boone. Pp. 8+3 plates. Scientific Results of the Second Oceanographic Expedition of the *Pawnee*, 1926. Vol. 2, Art. 1: Elasmobranchii from Panama to Lower California. By C. M. Breder, Jr. Pp. 13+9 plates. Vol. 2, Art. 3: Nematognathi, Apodes, Isospondyli, Synentognathi and Thoracostraci from Panama to Lower California; with a Generic Analysis of the Exocœtidæ. By C. M. Breder, Jr. Pp. 25. (New Haven, Conn.: Bingham Oceanographic Collection, Peabody Museum of Natural History.)

CATALOGUE.

Bulletin des Publications nouvelles. 3e et 4e trimestres, 1927. Pp. 80. (Paris: Gauthier-Villars et Cie.)

Diary of Societies.

SATURDAY, APRIL 21.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Newcastle-upon-Tyne), at 2.30.—Dr. W. Cullen: Some Notes on Quarrying by the Well Drill Method.—R. J. Weeks: A Few Notes on an Explosion of Gunpowder.—Discussions on Electric Mine Lamps and Better Lighting, W. Maurice; A New Gas Detecting Miners' Electric Lamp, Prof. W. M. Thornton; and Notes on High Candle-power Lamps, H. Staples.

MINING INSTITUTE OF SCOTLAND (Annual General Meeting) (at Royal Technical College, Glasgow), at 3.—J. A. B. Horsley: Design and Maintenance of Flame-Proof Enclosures, with Special Reference to Coal Face Machinery.—Discussions on Supporting Underground Roadways with Steel Arches, D. C. Gemmell; and Life Saving in Colliery Explosions and Fires, T. A. Southern.

MONDAY, APRIL 23.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section, London), at 6.30.—H. Heywood: Pulverised Coal Systems.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—Annual General Meeting.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—H. S. G. Rendel: The Work of Temple Moore.

ROYAL SOCIETY OF ARTS, at 8.—A. G. Huntley: Applied Architectural Acoustics (Dr. Mann Lectures) (II.).

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—Dr. A. Livingston: Further Experiments on the Permeability of Enamel.—W. Rushton: Injection of Alcohol for Neuralgia and its Sequel.—L. Payne: A Paste for Obtunding Hyper-sensitive Dentine.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—F. Rodd: Journeys among the Southern Tuareg.

TUESDAY, APRIL 24.

ROYAL DUBLIN SOCIETY (at Ball's Bridge, Dublin), at 4.15.—Dr. J. H. J. Poole: A Simple Form of Photo Electric Photometer using a Neon Lamp to Measure the Current.

ILLUMINATING ENGINEERING SOCIETY (at Home Office Industrial Museum, Horseferry Road, Westminster), at 6.—J. S. Dow and others: Discussion on Daylight, Artificial Light, Artificial Daylight: their Merits and Drawbacks.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Kinematograph Group), at 7.—G. Malin: A Motor Cycle World Tour.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—M. C. Burkitt: South Africa's Past in Stone and Paint.

WEDNESDAY, APRIL 25.

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (in Prince Henry's Room, 17 Fleet Street), at 5.30.—L. F. Loree: Steamers of Lake Champlain, 1809 to Present Day.

INSTITUTION OF CIVIL ENGINEERS (Annual General Meeting of Association of London Students), at 6.30.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (Annual General Meeting) (at University, Birmingham), at 7.—Sir Oliver Lodge: The Revolution in Physics (Kelvin Lecture).

ROYAL SOCIETY OF ARTS, at 8.—Dr. J. M. Ritchie: The Education and Training of the Blind.

EUGENICS SOCIETY (at Royal Society), at 8.30.—Dr. Feldman: Eugenics in Ancient Hebrew Literature.

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (at Royal Anthropological Institute), at 8.30.—Drs. E. A. Bennet, D. Bryan, and T. A. Ross: Symposium on Fugue States. Discussion opened by Dr. T. W. Mitchell.

BRITISH ASTRONOMICAL ASSOCIATION (at Sion College, Victoria Embankment).

THURSDAY, APRIL 26.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—A. Besicovitch and H. Bohr: On Almost Periodic Properties of Translation Numbers.—W. L. Ferrar: Conditionally Convergent Double Series.—R. M. Gabriel: An Additional Proof of a Theorem upon Rearrangements.—Margaret E. Grimshaw: A Contribution to the Theory of Uniqueness of Representation by Trigonometrical Integrals.—Prof. A. E. H. Love: Biharmonic Analysis especially in a Rectangle and its Applications to the Theory of Elasticity.—S. W. P. Steen: On Fermat's Last Theorem.—C. T. Preece: Theorems stated by Ramanujan. (I.) Theorems on Integrals.—Prof. G. N. Watson: Theorems stated by Ramanujan. (II.) Theorems on Summation of Series.—Rosalind C. Young: On Riemann Integration with respect to an Additive Function of Sets.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—C. Dornier: Flying Boats.

INSTITUTION OF CIVIL ENGINEERS (Yorkshire Association) (at Hotel Metropole, Leeds).—C. J. Chaplin: Railway Construction in the Pyrenees.

FRIDAY, APRIL 27.

ROYAL SANITARY INSTITUTE (at Guildhall, Worcester), at 4.—C. C. Duncan and others: Discussion on River Pollution.—Dr. M. Read and others: Discussion on Infant Mortality in Worcester from 1895 to 1925.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—Prof. W. C. Baker: Experiments with Mercury Jets and the Phenomena exhibited at their Impact with Steel and Glass.—E. P. Perman and W. D. Urry: The Elastic Constants of Glass.—G. E. Bell: A Valve-maintained High-frequency Induction Furnace and some Notes on the Performance of Induction Furnaces.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section) (Annual General Meeting), at 6.15.—R. A. Brockbank: Super Tension Cables.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—J. C. Armstrong and others: Pulverised Fuel in Locomotive Furnaces.

INSTITUTION OF ELECTRICAL ENGINEERS (at Newcastle-on-Tyne), at 7.30.—E. T. Williams: The Electrical Equipment of the Singapore Floating Dock.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—C. H. Plant: The Manufacture of Structural Steel, etc.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Dr. R. W. A. Salmond: Observations on the Movements of the Duodenal Contents, with Special Reference to Antiperistalsis and Pyloric Regurgitation.—Dr. Bathurst: Treatment of Incontinence in Women.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. A. M. Tyndall: Carriers of Electricity in the Atmosphere.

INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (at Forresters' Hall, Dundee).—Dr. S. Z. de Ferranti: Electricity in the Service of Man (Faraday Lecture).

SATURDAY, APRIL 28.

ROYAL SANITARY INSTITUTE (at Guildhall, Worcester), at 10 A.M.—T. Caink and others: Discussion on The Worcester Activated Sludge Plant.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates and Students' Section) (jointly with Students' Sections of North-East Coast Institution of Engineers and Shipbuilders, and Institution of Electrical Engineers) (at Neville Hall, Newcastle-upon-Tyne), at 3.—L. H. Forster: Notes on Main Pumping.

PUBLIC LECTURES.

THURSDAY, APRIL 26.

BIRKBECK COLLEGE, at 5.30.—Prof. P. Debye: The Electrical Theory of Molecular Constitution. (Succeeding Lectures on April 27 and 30.)

KING'S COLLEGE, at 5.30.—Dr. K. Bělař: The Mechanism of Mitosis.