

NEW BOOKS.

Vorlesungen Über die Theorie der Wärmestrahlung. By DR. MAX PLANCK.
Leipzig: Johann Ambrosius Barth, 1913. Pp. xii + 206. Price, Mk. 7.

There is no doubt that the first edition of this volume of Planck's, and the articles which preceded it, have been the most stimulating contributions to physical literature of many decades, and since the second edition involves some radical changes in the point of view it is of fresh interest and importance.

The characteristic feature of the quantum hypothesis as used in the first edition to deduce the energy distribution law for a black body or perfect radiation was this, that the energy content of a resonator must always be an integral multiple of energy ϵ , whose magnitude depended on the frequency of the resonator, being $h\nu$, where ν is the frequency of the resonator and h is the quantum or unit of activity introduced by Planck. This idea of integral energy-content involved the further hypotheses of discontinuous absorption and emission of radiant energy on the part of the resonator. The commonly accepted idea of the early quantum theory seems to be that this discontinuity of absorption and emission necessarily involves the idea of attributing a granular *structure* to radiant energy in space. This is not necessary however, and the discontinuous behavior might better be attributed to a peculiarity of resonator (atomic) structure. In the second form of the quantum theory of radiation as presented in this new edition, and the articles on which the revision is based, the hypothesis of discontinuous changes in energy content is given up, absorption is supposed to be a continuous process taking place according to the ordinary laws of electro-dynamics, while emission is still considered as discontinuous. It is supposed that a resonator can only emit when its energy content is some integral multiple of $\epsilon = h\nu$. When emission occurs the resonator loses all of its energy, and the probability of emission actually occurring at the possible times is determined by a probability function which increases as the energy content increases. This change in the point of view, as well as an article of Planck's which has appeared subsequent to the publication of this second edition of his lectures, makes still more evident that the quantum theory is really a theory of resonator structure, or atomic structure, if it is to be extended to anything beyond Planck's ideal resonators. The fundamental hypotheses as to the relation between entropy and probability, and the definition of probability remain as in the first edition, but the new point of view necessitates an entire rediscussion of the relation between the mean energy and entropy of a group of resonators. The restriction that energy interchange occurs only between resonators of the same frequency, so that the resonators as a whole would not of themselves assume a particular equilibrium distribu-

tion of energy, still holds as in the first treatment, though in the later article above referred to Planck suggests one way of removing this restriction. The outcome of the whole discussion is the well-known Planck law of energy distribution.

Planck was led to the change in hypotheses which we have just outlined because the hypothesis of discontinuous absorption seemed unreasonable. A skeptic might question whether discontinuous absorption is any more unreasonable than discontinuous emission—or indeed whether “reasonable” and “unreasonable” have any meaning whatever in connection with much of the present day discussion, but there is no doubt of the clearness and frankness with which Planck has stated his hypotheses. Nor does there seem to be any doubt that he has introduced a constant “ h ,” which is of far-reaching significance, whatever that significance may be, and the tremendous stimulating power of his ideas is evident to every one.

C. E. M.

Electric Arcs. Experiments upon arcs between different electrodes in various environments and their explanation. By C. D. CHILD, Professor of Physics at Colgate University. The D. Van Nostrand Co. 5×7, cloth, 203 pp., 58 illustrations. \$2.00.

This book deals with the arc primarily from the point of view of pure science rather than that of industry, though its conclusions have a practical as well as a scientific interest. It is a well-written, careful presentation of the often conflicting results of many investigators, made by one who has himself carried out important researches in this field. Though fifteen years have passed since Mrs. Ayrton's book on “The Electric Arc,” our knowledge of it is still in many respects incomplete and unsatisfactory. Hence, instead of giving “a brief and definite statement of the laws governing the action of the arc,” the author has been compelled, as he says, to present “an extended review of what different experimenters have thought about these laws,” and, where the laws are unknown, to “discuss the results of those who have endeavored to find them.” Such a method is likely to lead to a wearisome collection of details; but in this case the discussion is ably conducted, terse and constructive. Hundreds of references to original articles make the book especially valuable to future investigators. To most of us the final chapter on the theory of the arc is of chief interest. The author's conclusions as to the mechanism of the arc, though largely unproved by experiment, yet seem to follow convincingly from the preceding analysis of available data. They give the most complete and suggestive explanation of the phenomena so far advanced.

G. S. F.

UNIVERSITY OF WISCONSIN.

Rays of Positive Electricity and Their Application to Chemical Analyses. By SIR J. J. THOMSON. New York: Longmans, Green and Co., 1913. Pp. vi + 129. Price \$1.40.

This volume is one of a series of monographs on physics edited by Sir J. J. Thomson, O.M., F.R.S., and Frank Horton, D.Sc. It contains an account

of the earlier experiments by Goldstein, Wien, and others, on anode or positive rays and also of the later ones in this same field by Sir J. J. Thomson himself. Full descriptions are given of the various types of apparatus used to investigate the properties of these rays. Accounts are given of the experiments which established the existence of multiply charged atoms, of allotropic forms of neon and of hydrogen, and of the molecular groupings represented by CH , CH_2 , and CH_3 . Reference is also made to the Doppler effect observed by Stark, Steubing, and Wendt in their investigations of the spectra of positive rays. The book concludes with a description of Sir J. J. Thomson's latest experiments on the evolution of helium and neon by substances bombarded by cathode rays. The work is full of suggestions and will prove a valuable aid to those following or wishing to become familiar with the manner in which positive rays have been used to add to our knowledge of the ultimate structure of matter.

J. C. M.

Recent Physical Research. By DAVID OWEN. London: The Electrician Printing and Publishing Co., 1913. Pp. i + 156. Price 3s. 6d.

This volume, which is a reprint of a series of articles published in the *Electrician*, aims at giving an account of a number of the more important of the recent advances in physics. The subjects dealt with are (1) rays of positive electricity and their applications to chemical analysis by Sir J. J. Thomson, (2) Rutherford's and Geiger's method of counting the alpha particles, (3) the work of Curie, Langevin, and Weiss, in developing a theory of magnetism, (4) Birkeland and Störmer's theory of the origin of auroræ, (5) the Brownian movement as investigated by Perrin, (6) the pressure of radiation, (7) Rubens, work on very long infra-red rays. (8) determinations of the wave-lengths of Röntgen rays, (9) the electron theory of conduction in metals, and (10) Heusler's aluminium-copper-manganese magnetic alloys. The various accounts are written with care and accuracy and the book should be useful to those for whom the original papers are not accessible. Subjects which might have been included in the book with advantage are: Paschen's work on series spectra, and the contributions of Wood, Lenard, and others, to our knowledge of phosphorescence and fluorescence phenomena.

J. C. M.

Die Theorie der Strahlung und der Quantum. Verhandlungen auf einer von E. Solvay einberufenen Zusammenkunft (30. Oktober bis 3. November 1911). Edited by A. EUCKEN. Halle: Wilhelm Knapp, 1914. Pp. xii + 405. Price Mk. 15.60.

This book is the counterpart in German of the French report of the Solvay conference which was published in 1912 by Langevin and de Broglie. Eucken has added a valuable appendix giving an account of the development of the quantum theory down to the summer of 1913. The papers presented at this conference are of the highest order. H. A. Lorentz discusses the application of the equipartition of energy to radiation. Jeans presents the kinetic theory of specific heat by Maxwell's and Boltzmann's methods. Warburg describes

experiments to verify Planck's formula for normal radiation and Rubens describes experiments with long waves. Planck discusses the laws of radiation and the quantum hypothesis; Knudsen, the kinetic theory and the properties of the ideal gas; Perrin, the proof of the existence of molecules. Nernst applies the quantum theory to physical and chemical problems. Kamerlingh Onnes deals with electrical resistance. Sommerfeld applies the quantum theory to radiant pulses. Langevin presents the kinetic theory of magnetism. Einstein discusses specific heats. Lord Rayleigh contributes a short letter. Other leaders of modern physics, Rutherford, Mme. Curie, H. Poincaré and others, took part in the discussions. The book is of the greatest interest and importance.

W. F. M.

Physikalische Chemie der homogenen und heterogenen Gasreaktionen unter besonderer Berücksichtigung der Strahlungs- und Quantenlehre sowie des Nernstschen Theorems. By DR. KARL JELLINEK. Leipzig: S. Hirzel, 1913. Pp. xiv + 844. Price, Mk. 32.50.

This book contains much more than its name indicates. It opens with a study of Carnot's cycle and in the first two hundred pages there are given a development of the more modern thermodynamics, so far as it is needed in the applications to gases, and a sketch of the kinetic theory of gases. Nernst's principle of thermodynamics is considered in this portion of the book from its relations to entropy. Over one hundred and fifty pages are then given to an exposition of the theory of radiation and over one hundred pages more to the study of the relations of the theory of radiation to the theories of specific heats, of heats of reaction, and to Nernst's principle. The experimental work connected with the foregoing theories is described in two hundred pages more. The last hundred pages deal with the electrochemistry and the photochemistry of gases. The physical chemistry of gases takes up but a small part of the book. The author has studied his subject fully, he gives careful criticisms of the points of difficulty which occur so often in these modern theories, and has made a book which will be very useful for study and for reference.

W. F. M.

Die Entwicklung des Temperaturbegriffs im Laufe der Zeiten. By K. MEYER. Braunschweig: Vieweg and Sohn, 1913. Pp. 1 + 160. Price, Mk. 4.

The greater part of this small volume is devoted to the development of the concept of heat and temperature from the invention of a thermometer (about 1610) to the introduction of the Kelvin absolute thermodynamic scale. A very brief introductory chapter merely sketches the earlier period, before Galileo, and an equally brief final chapter states, in very good form, the hypotheses on which our present measurements rest, indicates the thermodynamic connection between the Kelvin scale and a gas scale, and gives a few results of measurements at extreme low temperatures. The main body of the book is well indexed and full of references, but is more largely concerned, of necessity, with quaint ideas than with important logical developments. No mention is made of the

growth of the kinetic theory of matter in its relation to temperature, nor of the relation of radiation theory to temperature, though both of these are of fundamental importance in the development of the concept. C. E. M.

Optique Geometrique. By J. BLEIN. Paris: Octave Doin et Fils, 1913. Pp. vi + 263. Price, 5 Fr.

The usual topics of geometric optics are clearly and briefly treated in this small volume. Of the eleven chapters three are devoted to the general subject of image formation, three to the general discussion of optical instruments, as to their magnifying power, field, resolving power, focal surface and brightness, and three to the more detailed discussion of aberrations and the characteristics of various types of objectives. There are enough diagrams to make the treatment clear, and the usefulness of the book is increased by an index and bibliography. C. E. M.

Researches in Color Vision and the Trichromatic Theory. By SIR WILLIAM DE W. ABNEY. New York: Longmans, Green and Company, 1913. Pp. x + 418.

As stated by the author in his preface, this book was written with a two-fold purpose, namely: to make his published contributions (extending over twenty-five years) more conveniently accessible; and, "to show that the trichromatic theory of color vision does not yet require a funeral oration over its remains."

It is divided into two parts, of which the first, comprising one third of the book, has been the subject of lectures to students. A general introductory chapter is followed by one on the eye and another on phenomena in vision. A description of measuring instruments is then followed by a chapter on the intensity of spectrum colors and one on their relative brightness or "luminosity." With a chapter on each of the subjects: "Complementary and Contrast Colors," "Numerical Registration of Colors," and "Color Disks," the first part is completed. Part II. opens with an interesting chapter on Extinction of Color and Light—a corresponding laboratory investigation of the commonly observed change in hue, as the day closes, of bright-colored flowers and foliage. This is followed by another on "Color Fields"—the areas on the retina capable of distinguishing the various colors—after which the author turns his attention to the theory of color vision and the various experimental observations incident to this study, of which that on color blindness occupies a large part. The style is lucid and the typographical effect pleasing. C. A. S.

Les Propriétés Optiques des Solutions. By C. CHÉNEVEAU. Paris: Gauthier-Villars, 1913. Pp. vii + 240.

This is essentially a second edition of the author's work entitled *Recherches sur les propriétés optique des solutions et des corps dissous*. It is of value to the physicist who is especially interested in the optical properties of solutions, and to the chemist who seeks a knowledge of chemical composition of bodies by means of their optical properties.

The first two chapters are devoted to a critical presentation of the theories of refraction and dispersion including those of Havelock and Langevin—the most recent. The next three present the results of the experimental study of refraction and dispersion of aqueous solutions (and mixtures) of inorganic substances, and also of those not entirely aqueous. Chapter VI., of special interest to chemists, deals with the determination of the chemical composition of organic substances by means of their optical constants. The book closes with a chapter, uniquely placed, on apparatus and methods of measurement. The large bibliography at the end shows the vast amount of work which has been done in this and closely allied fields.

C. A. S.

Medizinische Physik. By PROF. DR. OTTO FISCHER. Leipzig: S. Hirzel, 1913. Pp. xx + 1120. Price Mk. 36.

This voluminous work attempts to develop those somewhat advanced principles of physics which lie beyond the scope of the ordinary elementary text, but which are indispensable from the point of view of the advanced student of medicine. The method of treatment while aiming to be non-mathematical involves quite freely the differential calculus, but not the integral. The various subjects are developed solely from examples of their application in the animal body. For instance the the center of motion of gravity of the human body in walking serves as a basis about which to develop ideas of composition of velocities and accelerations, their tangent and normal components and methods of graphical representation including the hodographs. Rotations are taken up in connection with linkages and the detailed analysis of the motions of the arms and the legs is given. The humero-radial linkage serves to introduce the idea of instantaneous axis of rotation and generalized coördinates are used.

Under the excellent title of Muscle Mechanics are introduced the various ideas of mass and force. The composition of forces, and moments with the resulting effects of motion, rotatory and translatory, with reference to the center of mass are studied from examples of various muscle and bone combinations familiar to the anatomist.

In acoustics the development of the fundamental principles of wave motion and the applications to sound, together with Fourier's analysis, quite obviously, has nothing to do with the human body. An elaborate treatise of the physical phenomena occurring in the ear, its structure, theories of audition and the mechanism of the production of speech makes this section in keeping with the general plan.

Optics from the geometrical standpoint is handled at great length, occupying about five hundred pages. The applications of the laws of reflection and refraction not only to the human eye but to lenses of all sorts, the telescope, the microscope in great detail—together with general considerations of the lens errors, astigmatism, spherical and chromatic aberrations, go rather far afield from the general plan of confining attention to the human body. The Abbe theories of image formation, ultramicroscopy and the applications of polarized light to the polarization microscope and the polarimeter conclude this division and the entire work.

Of the tremendously important applications of electricity to modern applied physics and to medicine no mention is made whatever, it being suggested in the preface that medical men are better informed in these directions.

H. B. L.

UNIVERSITY OF CHICAGO.

Bausteine zur Flugbahn-und-Kreisel Theorie. By AUGUST DAHNE. Berlin, R. Eisenschmidt, 1914. Pp. i + 44.

This monograph is of primary interest to students of ballistics. Its author, an army officer, assuming familiarity with the gyroscopic properties of projectiles comments on the causes of the well-known deviations of the axis of rotation. Having previously demonstrated that in tops these deviations are caused primarily by friction effects on the axis, in this pamphlet he shows that for projectiles too the air friction (Magnus effect), is the true cause and that the experimental facts brought out during the last 36 years are in accord with this and do not bear out the Poinot theory which is based on the principle of infinitely small rotations.

H. B. L.

UNIVERSITY OF CHICAGO.

Optique Physique. By R. W. WOOD. Translated from English by H. VIGNERON and H. LABROUSTE. In two volumes: Tome I. *Optique Ondulatoire* (translated by H. Vigneron), 1913; Tome II., *Étude des Radiations* (translated by H. Labrouste), 1914. Paris, Gauthier-Villars.

This is a careful translation of the second edition of Professor Wood's excellent treatise. Being spread over two volumes, the translation makes a much more pleasing typographical effect than that of the somewhat congested single volume of the original. Several paragraphs of new matter by the author, dealing principally with fluorescence and resonance spectra of vapors, appear in the second volume.

C. A. S.

Elements of the Precision of Measurements and Graphical Methods. By H. M. GOODWIN. New York: McGraw-Hill Book Company, 1913.

This is an elementary treatise of experimental errors and graphical methods for technical students. It will be found a very good presentation for those who believe in the applicability of the method of least squares to technical subjects.

C. A. S.

The Chemistry of the Radio-Elements. By FREDERICK SODDY, F.R.S. New York: Longmans, Green and Co., 1914. Pp. i + 46. Price, \$.60.

This brief monograph brings together a number of the more recent experimental contributions to our knowledge of the radio-elements. In attempting to fit all the known radio-elements into the periodic table the author brings forward the view that "isotopism" exists in nature and that as a consequence a number of the radio-elements being chemically non-separable are practically

identical. The work includes chapters on the origin of actinium, the nature of the end products in radioactive disintegration, the structure of atoms, and the nature of the Argon gases. The work concludes with an extended list of references to recent papers on the subjects discussed.

J. C. M.

A New Era in Chemistry. By HARRY C. JONES. New York: D. Van Nostrand Company, 1913. Pp. xii + 326. Price \$2.00.

This work, attractively written, is a popular presentation of the advances which have been made in the different branches of chemistry in the last quarter of a century. The various subjects treated are given an historical setting and the book abounds with references of a personal nature which throw considerable light on the methods followed by the different investigators. The work contains chapters on the Law of Mass Action; the Development of Stereochemistry; the Phase Rule; Chemical Equilibrium; Osmotic Pressure; Electrolytic Dissociation; the Theories of Solution, Colloidal Chemistry; Ionization of Gases and Radiochemistry. In the treatment of these subjects the fundamental character and the scope of the contributions made by Van't Hoff, Arrhenius, Willard Gibbs, Ostwald, and J. J. Thomson are all clearly and well portrayed.

J. C. M.

A First Course in Physics. (Revised Edition.) By R. A. MILLIKAN and H. G. GALE. New York: Ginn and Company, 1913. Pp. x + 442. Price, \$1.25.

The changes which have been made in the revised edition of this little book include a number of interesting features. The list of portraits inserted has been extended to include a few of the more eminent of modern physicists. The portions dealing with mechanics and the principles underlying the dynamo and motor have been simplified, and in light more emphasis has been laid upon a combination of the wave and the ray methods in the treatment of image formation. In the interpretation of the phenomena of molecular physics frequent use is made of the kinetic theory of matter and of the atomic or electronic theory of electricity. Altogether the book constitutes an admirable introduction to the study of physics.

J. C. M.

Geometrical Optics. By A. S. PERCIVAL. New York: Longmans, Green and Co., 1913. Pp. vi + 132. Price, \$1.50.

Students and others desiring what may be called an intermediate treatment of geometrical optics will find this book exceedingly useful. In developing the subject the author has omitted all reference to matters of purely academic interest and has confined his treatment to those phases of the subject which are more especially capable of practical application. The proofs given are concise and the sequence is excellent. The numerical illustrations of the various formulae used in the book constitute a particularly attractive feature.

J. C. M.

First Course in Algebra. By W. B. FITE. Boston: D. C. Heath and Co., 1913. Pp. v + 285. (Received.)

Die Brownsche Bewegung und Einige Verwandte Erscheinungen. By G. L. DE HAAS-LORENTZ. Braunschweig: Vieweg and Sohn, 1913. Pp. i + 103. Price, Mk. 3.50.

Previous books on Brownian movements have been primarily reports from certain experimenters upon their own experimental results. The book before us, which grew out of a Doctor's thesis, is a very valuable summary of most of the important *theoretical* as well as experimental researches on Brownian Movements which have appeared up to the present time. It is invaluable for a student of this subject. Indeed I know of no other book in which the subject is treated in any such thoroughgoing way. The original features are mainly in the latter chapters and consist (1) in the discussion of the relation between the actual, complicated Brownian movement and the visible motion of the Brownian particle, and (2) in certain additions to the theoretical study of the spontaneous transport of Electricity by Heat.

R. A. M.

Photo-Electricity. The Liberation of Electrons by Light with Chapters on Phosphorescence, Photo-chemical Actions and Photography. By H. STANLEY ALLEN, M.A., D.Sc. London: Longmans Green & Co. Pp. i + 216. Price, \$2.10.

The task of correctly portraying the present status of photo-electric research is a very difficult one, for the reason that, though the papers which have appeared in this field may be numbered literally by the thousand, there is as yet no unified and consistent theory in the light of which all the phenomena of Photo-electricity may be interpreted. How then is an author to choose between conflicting results and present only material which is of real significance? Or, if he strives to be quite impartial, how is he to avoid making his book a mere compendium of disconnected researches and of irreconcilable view-points?

Dr. Allen has met these inherent difficulties with notable success. He shows a thorough familiarity with the whole of the literature and at the same time he has shown much judgment in sifting it out and in getting each research into some sort of a theoretical setting. The chapters which present the relations to the Electron Theory of the phenomena of Fluorescence, Photo-chemistry and Photography are particularly valuable.

The fact that it takes a book of 216 pages to present at all adequately a subject as new and as undeveloped as is Photo-electricity shows with what amazing rapidity Physics is growing at the present time.

R. A. M.