lated from the straight line portion of the oxygen uptake–time curve on the basis of 1 cu. mm./min. for *p*-cresol-tyrosinase, and the influence of the test substances on the induction period was recorded (Table I).

TABLE I

INFLUENCE OF *p*-AMINOBENZOIC ACID AND STRUCTURALLY-RELATED COMPOUNDS ON OXIDATION OF *p*-CRESOL CATALYZED BY TYROSINASE

Test substance	Induction period	O_2 uptake cu. mm./min.
None (control)	Standard	1.00
p-Aminobenzoic acid[a]	Shortened	3.63
m-Aminobenzoic acid[a]	Shortened	2.49
o-Aminobenzoic acid[a]	Shortened	2.10
Aniline	Shortened	1.75
p-Hydroxybenzoic acid[a]	Unaltered	1.13
Sulfanilamide	Shortened	1.03
Benzoic acid	Lengthened	0.99

[a] Sodium salt.

It is apparent that the three isomeric aminobenzoic acids accelerate the rate of oxygen uptake more than any of the other substances studied, the para compound always having the greatest influence. The acceleration due to aniline is enhanced by a carboxyl and diminished by a sulfonamide group in the para position. The response to *p*-aminobenzoic acid is only slightly weaker when sulfanilamide is present simultaneously, the former having apparently a higher affinity for the enzyme than the latter. Whether *p*-aminobenzoic acid accelerates an oxidation (*i. e.*, *p*-cresol) catalyzed by tyrosinase or retards it (*i. e.*, tyrosine, dopa), its influence is always more pronounced than that of sulfanilamide. Their observed opposite effects lend credence to the suggestion that their antagonistic behavior with respect to bacteria is due to a common point of attack in bacterial enzyme systems [D. D. Woods, *Brit. J. Exptl. Pathol.*, **21**, 74 (1940)]. The significance of the activity of *p*-aminobenzoic acid in oxidation processes catalyzed by tyrosinase, reported to have an influence on blood pressure [H. A. Schroeder and M. H. Adams, *J. Exptl. Med.*, **73**, 531 (1941)], is being studied in experiments on hypertension.

RESEARCH LABORATORY OF THE INTERNATIONAL VITAMIN CORPORATION AND THE WARNER INSTITUTE FOR THERAPEUTIC RESEARCH
NEW YORK, N. Y.
W. A. WISANSKY
GUSTAV J. MARTIN
S. ANSBACHER

RECEIVED MAY 20, 1941

NEW BOOKS

Qualitative Analysis and Chemical Equilibrium. By T. R. HOGNESS, Professor of Chemistry, and WARREN C. JOHNSON, Associate Professor of Chemistry, University of Chicago. Revised edition. Henry Holt and Company, 257 Fourth Ave., New York, N. Y., 1940. xvi + 538 pp. 33 figs. 15 × 22.5 cm. Price, $2.90.

The appearance of a revised printing is a good indication of the reception accorded the previous edition (review in THIS JOURNAL, **59**, 2080 (1937)). The new book is larger by some 120 pages, the revision having been fairly extensive, involving considerable rewriting and insertion in all chapters except II, IV, IX and the Appendix. Chapter I has a more extensive treatment of ionic structure; II, VI and VIII present the subject on the basis of the Brönsted theory; and more or improved problems and examples appear in several chapters.

The really significant changes have been made in Section II, the Experimental Part, now divided into numbered chapters. The experimental philosophy of the first edition was a small scale adaptation of the Fresenius qualitative procedure, based on the premise that ordinary large test-tube and funnel work has little merit in the acquisition of skill, deftness and scientific appreciation. The revision profits from experience: the procedures have been changed here and there, amplified, and presented, where necessary, in alternate forms, to permit their use with small filters and funnels or centrifugal settling of precipitates. The section on anion analysis has been extended and improved, and the chapter on Preparation of Substances for Analysis is now very well done.

The literary style and methods of presentation are simple and matter-of-fact; typography, printing and paper are excellent (the reviewer does not like the press style which omits periods after abbreviations, and zero's before decimal points). The first edition has been a popular text; the revision should be received even more favorably.

ALLEN D. BLISS

A Laboratory Guide for Organic Chemistry. By E. WERTHEIM, Professor of Organic Chemistry in the University of Arkansas. Second edition. The Blakiston Company, 1012 Walnut Street, Philadelphia, Penna., 1940. 550 pp. 24 illustrations. Price, $2.50.

The second edition of this book contains 169 experiments dealing with the preparation, properties, and identification

of organic compounds. Although there is little novelty in the choice of material, the wide variety of experiments which this work offers should make it adaptable to almost any course in general organic chemistry. The clarity of the experimental directions, many of which anticipate probable errors on the part of the student, gives evidence of the author's forethought and his experience in this field.

The book has detachable report sheets following most of the experiments which contain, besides space for essential data, many questions pertaining to the theory and applications. The experiments on the identification of organic compounds and on the properties of typical members of important homologous series are inserted at appropriate places throughout the manual. Time tables which give the average time required for the different steps of each experiment, should aid students in planning their work.

In the reviewer's opinion the author's success in arranging and presenting, in a practical and useful manner, the great wealth of material contained in this manual is a notable accomplishment.

WILLIAM P. CAMPBELL

The Pharmacological Basis of Therapeutics. A Textbook of Pharmacology, Toxicology and Therapeutics for Physicians and Medical Students. By LOUIS GOODMAN, M.A., M.D., Assistant Professor of Pharmacology and Toxicology, Yale University, and ALFRED GILMAN, Ph.D., Assistant Professor of Pharmacology and Toxicology, Yale University. The Macmillan Co., 60 Fifth Avenue, New York, N. Y., 1941. xiii + 1383 pp. 18.5 × 26 cm. Price, $12.50.

Although this comprehensive treatise is written from a clinical point of view and is designed primarily for the use of medical students and practicing physicians, it can be recommended to chemists as constituting a valuable survey of the whole field of practical therapeutics. The book should prove useful as a work of reference for chemical libraries, for it provides authoritative and fully documented information concerning the actions and uses of the established drugs and of recently introduced therapeutic agents of recognized value or promise. Any one interested in the general subject of medicinal chemistry, whether it be in the capacity of student, teacher, or organic research worker, will find innumerable items of interest in this excellent book.

The drugs listed are grouped on the basis of therapeutic uses, and each chapter includes a presentation of the pharmacological actions and practical uses characteristic of the group as a whole; special features associated with the more prominent members of the group are then elaborated. The applications of the drugs in medicine are defined clearly and simply, structural formulas are given and, where significant data are available pertaining to the relationship between structure and pharmacological action, the main facts of the case are summarized in a lucid and interesting manner. Sections outlining the history and legends associated with the recognition of the therapeutic qualities of such familiar drugs as ether, caffeine, quinine, and digitalis make interesting reading for the chemist. A high quality of writing has been maintained throughout.

The authors are to be congratulated for their general success in keeping abreast of modern developments in the rapidly moving field of therapeutics. In a book of the size and scope of this treatise, a certain lag is almost inevitable. Thus, in this book dated November 1940, sulfathiazole is discussed, but no mention is made of pantothenic acid (structure and synthesis, March, 1940).

A few of the chemical formulas are in error (santonin, p. 884; progesterone, p. 1200; vitamin C, p. 1264); and certain others are written in an antiquated manner ("dioxyanthranol," or 1,8-dihydroxyanthranol-10, p. 873; acridine, p. 864; and atabrine, p. 918). Benzedrine is formulated correctly on page 400 but later (p. 435) defined misleadingly as phenylisopropylamine (it is the β-phenyl derivative of isopropylamine, or 1-phenyl-2-aminopropane). The authors also err in applying the term polymorphous to the several hormonal substances exhibiting oestrogenic activity (p. 1193), and to vitamins A_1 and A_2 (p. 1270); the existence of progesterone in two crystalline modifications (p. 1200) probably was the source of confusion. The statement regarding the supposed superiority of desoxycorticosterone over cortical extracts for the therapy of Addison's disease (p. 1237) unfortunately represents an early impression which is now generally discounted.

LOUIS F. FIESER

The Chemical Action of Ultraviolet Rays. By the late CARLETON ELLIS and ALFRED A. WELLS. Revised and Enlarged Edition by FRANCIS E. HEYROTH, M.D., Ph.D., University of Cincinnati. Reinhold Publishing Corporation, 330 West 42nd Street, New York, N. Y., 1941. ix + 961 pp. 159 figs. 16.5 × 23.5 cm. Price, $12.00.

The present author has transformed the familiar work of Ellis and Wells into a modern reference book on photochemistry. The list of topics has been expanded, and "the effort has been made to include citations to all work subsequent to the first edition (1925)." This objective has entailed prodigious labor, and has been virtually attained, well into 1939, as random tests of the bibliography will indicate. The author index now includes over eight thousand names, and the subject index nearly six thousand topics. Some readers might have welcomed a more severely critical treatment of those papers which have not stood the test of time.

The text falls into four parts: sources of ultraviolet radiations, 176 pages; photochemical processes, 335 pages; application to industry, 107 pages; biological applications, 216 pages. The use of a considerable part of the original treatise, and the determination to include all later references, have necessarily led to the retention of some material which is now obsolete, or which bears only upon highly specialized problems. This applies especially to the section on light sources, which discusses in great detail the construction and operation of numerous devices, and includes a hundred cuts. On the other hand, modern photochemical apparatus and procedures, especially quantitative technique, are handled mainly by reference, except in the industrial and biological sections.

As expected, the biological chapters are excellent, the discussion of vitamin D especially. Sterilization by ultraviolet light, and physiological effects of solar radiation will

repay careful study. Industrial topics such as deterioration of paper, textiles and rubber are presented in an adequate and interesting fashion.

Ovbiously the effort has been made to avoid extensive duplication of material which has been thoroughly organized by recent standard texts. The book excels in fields not hitherto covered in great detail. Therein lies its strength, and the need for it in every well-balanced chemical library.

GEORGE S. FORBES

Unsere Lebensmittel und ihre Veränderungen. (Our Food and its Changes.) By DR. WILHELM ZIEGELMAYER, Oberregierungsrat beim Oberkammando des Heeres, Berlin. Second edition. Verlag von Theodor Steinkopff, Residenzstrasse 32, Dresden-Bl., Germany, 1940. xvi + 401 pp. 16 × 23 cm. 87 figs. Price, RM. 9; bound, RM. 10.13.

In presenting food and the changes that take place in it during preparation, storage, processing and cooking, the author obviously has in mind the character and nutritive value and quality of the food as it appears on the table. This attitude is the logical accompaniment to the growing realization that food as served may fail through loss, particularly of vitamins and inorganic constituents, to supply the essential nutrients our food habits have led us unconsciously to expect from it—and this without obvious change in the superficial characteristics or even with apparent improvement in acceptability of foods. Such possibilities combined with an understanding of the consequences of specific malnutrition have introduced new problems that are not met by following our folkways blindly, and point the way to the type of information we must expect of those who manufacture and sell food.

The author presents the physico-chemical and biological changes in food and changes in quality that result from them primarily from the point of view of the effect the particular process has in relation to commercial and household practices. The various chapters relate to: changes in the composition of food between purchase and use (edible and inedible portions); the effect of heat (cooking) as applied in various ways; the preservation of food in a fresh state through cold, particularly freezing; the influence of the kind of cooking or preserving vessel, particularly the metals used; the effect of ferments and enzymes, autolysis; the changes occurring in preservation and storage; preservation or storage of food; the effect of microorganisms; protection of food against deterioration by molds and bacteria, technical procedures; changes produced by industrial and agricultural processes through additions and technical processes, including changes in quality; and the influence of the character of water in cooking. One chapter is devoted to experiments demonstrating the changes that occur in various foods. Other experiments are included in the chapter on the effect of heat.

The changes in composition of food between purchase and use are given largely in terms of cost and weight in relation to calories. Such a basis is primarily justified for those foods that make a major contribution to the energy requirement of man. Developments of the science of nutrition make it imperative, even though difficult, to evaluate foods in terms of the vitamins and inorganic elements as well as the proximate constituents. It is no longer justifiable to evaluate foods in terms of a single nutrient factor, often to the chagrin of the economist. In presenting information on losses in vitamins the author has confined himself largely to vitamin C, due in part to the fact that information on the other vitamins is very meager.

The book covers, at least in a broad way, most of the problems in the preservation and preparation of food, and with more detail those particular foods where they are especially affected by one or more of the processes. It is, however, particularly interesting because of the author's point of view in selecting and organizing the material in relation to the ultimate consumer, an attitude that is apparently the result of his interest in the problem of the supply and feeding of the German army as well as the public in general.

PAUL E. HOWE

Electrophoresis. Volume XXXIX. Art. 3, pp. 105–212 of the Annals of the New York Academy of Sciences. By HAROLD A. ABRAMSON, EDWIN J. COHN, BERNARD D. DAVIS, FRANK L. HORSFALL, LEWIS G. LONGSWORTH, D. A. MACINNES, HANS MUELLER and KURT G. STERN. New York Academy of Sciences, care of the American Museum of Natural History, New York, N. Y., 1939. 105 pp., paper covers. Price, $1.25. This monograph is one of several which if bought as a set may be had at a reduced price.

The American Chemical Society Monograph No. 66, "Electrokinetic Phenomena," appeared in 1934. Since that date the theory and practice of electrokinetics have made great advances. The present series of papers, presented as a symposium program, summarize the more important advances and are an invaluable supplement to the earlier volume.

The topics considered are "Theory of Electrophoretic Migration," "The Determination of the Electric Charge of Surfaces by the Microscopic Method of Electrophoresis," "The Moving Boundary Method for Studying Electrophoresis," 'The Observation of Electrophoretic Boundaries," "Characteristics of Protein Boundaries as Shown by Scale Method Electrophoretic Diagrams," and "The Influence of Ionic Strength and pH on Electrophoretic Mobility."

Electrophoresis has been abundantly demonstrated to be a potent tool in the characterization of colloid systems in general and of biocolloid systems in particular. This is especially true of the newer techniques developed by Tiselius and the special Schlieren and Lamm Scale optical methods which are here described and discussed by recognized authorities.

It would extend this review beyond any reasonable length to adequately summarize the individual papers—all are of the utmost importance to workers in the field—and any person or library possessing A. C. S. monograph 66 should secure the present monograph as a supplementary source of authoritative information.

ROSS AIKEN GORTNER

An Introduction to the Kinetic Theory of Gases. By SIR JAMES JEANS. The Macmillan Company, 60 Fifth Avenue, New York, N. Y., 1940. 311 pp. 35 figs. 14.5 × 22.5 cm. Price, $3.50.

The present work is a condensation of Jeans' earlier book, *The Dynamical Theory of Gases*. The range of material is more limited, with only two pages devoted to electrical phenomena in gases, and with no treatment at all of quantum mechanical phenomena. The subject matter is covered in a simpler and more physical manner than in the former book, "the physicist's need for clearness and directness of treatment, rather than the mathematician's need for rigorous general proofs, having directed the author's efforts throughout the book."

The emphasis of the book is placed upon the free-path concept. The first two chapters are devoted to introductory material, and the third contains a treatment of the pressure of a gas, with particular attention being paid to imperfect gases. The equations of van der Waals and of Dieterici are derived and discussed in some detail. Maxwell's distribution function forms the subject of the fourth chapter, and the fifth is devoted to a detailed study of the free path in a gas of hard elastic spheres. The tendency of the original velocity to persist after a collision is discussed. Chapters six, seven, and eight treat the phenomena of viscosity, thermal conductivity, and diffusion in dilute gases. The emphasis is again placed on the free-path point of view, although the results of the rigorous Chapman–Enskog theory are also stated.

A necessarily very incomplete account of the Maxwell–Lorentz–Enskog analysis of transport phenomena in nonuniform gases is presented in the twenty-eight pages of Chapter nine. The Maxwell–Boltzmann integral equation for the velocity distribution function is derived on p. 238, although neither its name nor its historic importance is pointed out. The remaining two chapters are devoted to a very brief discussion of statistical mechanics and to the elementary theory of the specific heats of gases.

There seems to have been little effort to include material more recent than that of the fourth edition of *The Dynamical Theory of Gases*. Indeed, in a book published nearly two years after the development of the Clusius–Dickel thermal separation column, it is a little startling to read the suggestion that thermal diffusion may "possibly" prove to be of value for the separation of isotopes.

The chief limitation of the book is its brevity and limited scope, which make the work less desirable for reference purposes. The prospective purchaser might well examine also the recent book by Kennard, which is somewhat more comprehensive. On the other hand, the book has the advantage of the entertaining and graceful style for which Sir James Jeans is deservedly so well known, as well as the advantage of a rather small cost.

A number of errors have been transferred from *The Dynamical Theory of Gases* to the present work. Equations (220) and (221) together are the result found by Chapman in his 1911 paper, but these equations are not confirmed by the rigorous Chapman–Enskog theory, as is implied at the top of p. 176. In order to agree with the Chapman–Enskog theory, the $(s - 1)$ in the square bracket of (220) should be replaced by the number two. Equation (263) is dimensionally incorrect, and contains another error as well: the force constant μ should have the exponent minus one-half, and the argument of the gamma-function should be $3 - 2/(s - 1)$. Finally, the number 1.504 given on p. 216 should be 1.543 according to the values of $I_1(5)$ and $I_2(5)$ given by Jeans, and has the value 1.550 according to Chapman's redetermination of $I_1(5)$ and $I_2(5)$.

R. CLARK JONES

Biochemistry of Symbiotic Nitrogen Fixation. By PERRY W. WILSON, Associate Professor of Agricultural Bacteriology, University of Wisconsin. University of Wisconsin Press, 811 State Street, Madison, Wisconsin, 1940. 15.5 × 23.5 cm. 34 figs. xiv + 302 pp. Price, $3.50.

This monograph closes with a quotation from Liebig—". . . we are too much accustomed to attribute to a single cause that which is the product of several, and the majority of our controversies come from that." There are few fields which better illustrate this failing than the investigations of the process of symbiotic nitrogen fixation, a phenomenon manifest only when a peculiar relationship between a bacterium and a higher plant has been established. Until recent years far more attention was directed toward the organism than the host legume, the latter being viewed at least as the junior partner if not quite as sleeping partner in the nitrogen-fixation firm. Extensive and intensive studies of the biochemistry of the relation between host plant and invader have revealed the fallacies in this assumption, and have demonstrated the possibility of treating the nodulated legume as a biocatalytic system the kinetics of which can be investigated by appropriate physicochemical methods.

This monograph is essentially a record of the far-reaching Wisconsin researches in this field presented against the background of current developments elsewhere. It may be considered as a biochemical sequel to the earlier volume by Fred, Baldwin and McCoy on "The Root Nodule Bacteria and Leguminous Plants," which was mainly an account of the bacteriological and agronomic aspects of symbiotic nitrogen fixation.

The most valuable chapters are those which deal with the physiology of the bacteria, the interaction of bacteria and host in fixation, the chemical mechanism of the fixation process and the physico-chemical characteristics of the nitrogen-fixing system. The literature is critically reviewed, and assembled in an admirable author index, complete with titles and full citations.

This book should appeal to chemists interested in the applications of biochemistry to the study of the nitrogen fixation process, and be most valuable to agronomists and bacteriologists concerned directly or indirectly with problems connected with the growth of legumes.

A. G. NORMAN

Fire from the Air, The A B C of Incendiaries. By J. ENRIQUE ZANETTI, Professor of Chemistry, Columbia University. Columbia University Press, Columbia University, New York, N. Y., 1941. 55 pp. Price, $0.50.

The pocket-size 54-page booklet prepared by Professor Zanetti from lectures "delivered to Fire and Police Inspectors" is interesting reading, particularly under present

conditions. A brief historical discussion of the use of incendiaries in warfare and of the factors which determine the suitability of an incendiary is followed by chapters describing specific materials such as oils, sodium, potassium, phosphorus, magnesium, aluminum, thermite and other incendiary mixtures. Other chapters are entitled "Incendiary Bomb Types" and "Strategy and Tactics." One does not have to be a chemist to understand the matters discussed and thus to obtain fundamental information regarding the various incendiary materials and their action. The reviewer finds the data given to be scientifically accurate but, from his experience, questions some of the minor opinions and conclusions expressed.

Because of the actual use at the present time of magnesium, aluminum and thermite as incendiaries the discussion of these materials is of special interest. Professor Zanetti points out many of the advantages and disadvantages of thermite and states that "thermite is by far the most satisfactory incendiary mixture." He might have also stated that thermite alone is not an ideal incendiary because it "burns" without appreciable flame and because the large quantity of heat generated very quickly by its reaction is dissipated and not effectively utilized unless secondary readily flammable materials such as "solid oil," magnesium, etc., are present. The most effective incendiary bomb developed during the World War, when magnesium was not available, contained thermite in a steel nose and "solid oil" and sodium blocks in a sheet zinc body structurally supported by a steel frame work. At the present time there seems to be no question but that the magnesium–thermite bombs are highly effective.

The reviewer was disappointed not to find a more detailed discussion of practical defense measures against modern incendiary bombs. Information (pages 29–31) regarding the action of the magnesium–thermite bombs is most interesting. It is pointed out that recent information from England indicates that adequate materials and equipment are absolutely essential to prevent fires being started by them. It might be mentioned that nothing can stop the thermite reaction once it has been started but that measures can be applied to cool effectively the molten iron formed and to prevent the bomb from starting a fire. Despite the fact that both water and carbon dioxide will react with magnesium, both of these agents can be used under proper conditions to prevent fires from being started by the bombs. A mixture of sand and powdered calcium or magnesium carbonate is recommended for smothering the magnesium–thermite bombs. The decomposition of the calcium and magnesium carbonates by the heat produces carbon dioxide which prevents the spread of the fire.

The booklet is recommended to chemists and non-chemists who desire general information regarding incendiaries.

A. B. RAY

Grundlagen und Ergebnisse der Ultraschallforschung. (The Principles and Accomplishments of Research in Ultrasonics.) By EGON HIEDEMANN, Dr. Phil. Professor für Physik an der Universität Köln. Walter de Gruyter and Co., Berlin W 35, Germany, 1939. 17.5 × 25 cm. 232 figs. ix + 287 pp. Price, RM. 24.00.

The purpose of this book, as stated in its preface, is to afford a systematic and critical presentation of research in ultrasonics, including the underlying principles, from the standpoint of the physicist. The systematic arrangement of the subject matter is based upon that employed by the author in a previous, briefer account in *Ergeb. exakt. Naturw.*, **14** (1935). A detailed discussion of the techniques employed and of the results attained in ultrasonic investigations is accompanied by a statement of problems still awaiting solution.

Following a brief historical introduction, the first chapter deals with the methods of production of ultrasound; the second, with mechanical and optical methods of investigating the sound field; the third, with the propagation of ultrasonic vibrations; the fourth, with their physicochemical and biological effects, as well as technical applications. Although the book will be of value primarily to physicists, a certain amount of interest to the chemist will be found, mainly in the last chapter, in which reference is made to the ability of ultrasonic (and sonic) energy to bring about various oxidation processes in aqueous solution, due to the activation of dissolved gases; to the depolymerization of various organic substances, and to various biological effects. Technical applications are described, including the preparation of emulsions, the dispersion and coagulation of colloidal materials, the testing of materials for defects, and the effects of ultrasonic vibrations upon molten metals and upon the crystal structure of solids. The final section of this chapter has timely interest, in that it considers underwater signalling, and methods of detection of submarine or surface craft. The appendices include a very extensive bibliography of some 1346 references, arranged alphabetically, probably the most complete of its kind.

The book is printed on paper of good quality, but the binding is inferior. Evidence of an attempt to conserve paper by compressing the material into the smallest number of pages is noted in the constant use of fine print, closely spaced, an expedient which is tiring to the reader, and if employed with paper of poorer quality would be intolerable. Economy in space is to some extent counteracted by a very liberal use of illustrations, which include an attractive full-page color plate.

WALTER C. SCHUMB

Electronic Processes in Ionic Crystals. By N. F. MOTT, M.A., F.R.S., and R. W. GURNEY, M.A., Ph.D. Oxford University Press, 114 Fifth Avenue, New York, N. Y., 1940. ix + 269 pp. 107 figs. 16.5 × 24.5 cm. Price, $5.50.

The scope of this work is well indicated by the chapter headings: I. The Perfect Ionic Lattice, II. Lattice Defects in Thermal Equilibrium, III. Electrons in Ionic Crystals, IV. Colour Centres in Alkali Halides and Allied Phenomena, V. Semiconductors and Insulators, VI. Luminescence and the Dissipation of Energy, VII. Photochemical Processes in Silver Halides and the Photographic Latent Image, VIII. Processes Involving the Transport of Both Ions and Electrons. In the first two chapters the structure of ionic crystals is sketched in respect of perfection and of dilapidations. Effectively only crystals of cubic lattice type are considered, a systematic treatment not being possible in the limits of space imposed. But one

would like to see greater acknowledgment of the variety of crystal—even ionic—architecture, and contrariwise of the specific intrusion of homopolar binding in such crystals. This bears on the theory of "lattice disorder," the quantitative aspects of which are presented in most clear and concise form. But it would seem well to remember here that disorder is relative, that "where we expect one kind of order, and find another, we term this disorder." It may happen that supposed interstitial and vagrant atoms in crystals are actually integrated in another type of order interpenetrating the principal lattice.

Chapter III contrasts the collectivist and atomistic treatments of electrons in crystals, indicating that the former has the advantage for metals and conducting states, the latter for the unexcited electrons of insulators. No mention is made of the work of L. Pauling on the "electron affinity of the crystal" (pp. 71–73) although he appears to have sponsored this somewhat elusive quantity. But not only new quantities but new entities are forthcoming in crystals, created perhaps "praeter necessitatem" but by charming mathematical velleity. The "exciton" and the "phonon" are rather ephemeral sprites compared with the rest of "the wonderful family named—on" but they have their day in the crystal, as corpuscular correlates of certain wave systems. "A place from which an electron is missing is a positive hole." And, (p. 84) not only do positive holes behave, on given occasion, like positive carriers of electricity but (pp. 89–90) "in a perfect crystal the combination of electron and positive hole trapped in one another's field" is able to move as a whole through the crystal. This is the exciton, which is also an excitation wave; the discussion of its two aspects in relation to the absorption of light is somewhat sketchy, and might be amplified. In particular, the paper by J. Franck and E. Teller (*J. Chem. Phys.*, 6, 861 (1938)) is more helpful to the chemist in development of the theory of Peierls and of Frenkel. In the present work there is somewhat of a gap between the introduction of the Peierls theory and the quantitative treatment of the absorption spectra of the alkali halides. These are discussed in terms of work cycles for the electron transfer in the crystal, as introduced by Herzfeld and Wolf, and the exciton is not explicitly considered. The photographic theorist must lament still the absence of any quantitative theory of the absorptions of the silver and thallous halides, whose diffuse bands appear definitely associated with the production of conducting states. The statement (p. 100) concerning the long wave tail: "It is responsible for the active absorption in, for example, photographic emulsions and phosphorescent materials" is too sweeping. The silver halides are strongly responsive photochemically in the ultraviolet.

The vast experimental material concerning colored alkali halides, largely due to the Göttingen school of Pohl and collaborators, is admirably collated in apt conjunction with the theory, to which the authors have made notable contributions. The same should be said of "Semi-conductors and Insulators." The importance of the purely chemical aspect is reflected in the statement "It seems that in the whole class of substances . . . intermediate between metals and insulators, the conductivity is due to the impurities they contain"—which in most cases means a stoichiometric excess of one constituent itself. The discussion of electron transfers between conductors, insulators and semi-conductors is particularly stimulating. In the field of luminescence one would like to see more consideration of lattice isomorphs—*e. g.*, the rôle of small amounts of arsenate, phosphate, vanadate, in luminescent calcium tungstate.

Chapter VII on "Photochemical Processes, etc.," summarizes important contributions to photographic theory by the authors or made under their inspiration. There are several criticizable statements which, however, suggest further investigation. That the "print-out" image is not structure sensitive is one. This appears inconsistent with the proposed mechanism of its growth, *viz.*, by electron charging of "specks" followed by attraction of mobile silver ions. Also the production of amounts of silver inside illuminated crystals, of the order of the external silver, indicates internal structure factors. The authors' description of photographic development lacks precision. The "induction period" has long been known to depend on the reducer, and T. H. James (*J. Phys. Chem.*, **43**, 701 (1939)) has shown recently that not the redox potential but the charge is responsible. The developability of silver halides increases from the iodide over the bromide to the chloride, *i. e.*, with the solubility; this does not agree with a theory based on silver ion mobility in the crystal. The hypothesis of color sensitizing by electron loss and recovery by the dye meets several difficulties. With basic dyes, the sensitizer is an adsorbed cation and the emitted electron would have to come from the resonance system. Also the quantitative data on optically sensitized photolysis are inconsistent with a very limited resupply of electrons adjacent to casual silver ion holes as pictured on p. 243. Explanation of the Herschel effect (red light bleaching of latent image) in terms of discharge of electrons from silver specks was made by Leszynski and others prior to the authors, but they have made interesting elaborations. Should "the spectral sensitivity of the process . . . resemble that of bleaching of F-centers in sodium chloride?" Hilsch and Pohl found that silver photo-halide illuminated monochromatically in its absorption band, unlike sodium photohalide (F-centers) bleaches selectively. This phenomenon (adaptation and Becquerel–Weigert effect) is not considered. The treatment of "tarnishing" reactions and of the decomposition of solids is brief, but stimulating. The book as a whole is both instructive and thought-provoking; it should be of great service to all interested in the behavior of solids. The type and figures are clear, and typographic errors are very scarce.

S. E. SHEPPARD

Photodynamic Action and Diseases Caused by Light. By HAROLD FRANCIS BLUM, Ph.D., The Washington Biophysical Institute. American Chemical Society Monograph Series. Reinhold Publishing Corporation, 330 West 42nd Street, New York, N. Y., 1941. xii + 309 pp. 1515 × 23.3 cm. 50 figs. Price, $6.00.

Photodynamic action is the term applied to the photosensitization of biological systems with fluorescent dyes in the presence of oxygen. The effects are initiated by photosensitized oxidations, the general characteristics of which can be reproduced *in vitro;* and they culminate in a variety

of striking and usually disastrous biological phenomena. Various examples of photodynamic action possess considerable chemical and physiological interest, and a number of photodynamic diseases are of great economic importance.

Dr. Blum has made important experimental contributions to almost all phases of this subject, and has done much to free it from a number of fundamental misconceptions which have bedeviled its history. The present monograph is a lucid, critical and integrative presentation of the field, and of its interrelations with a number of tangent phenomena. The book is divided into three sections, written so that they may be read independently of one another: a general and theoretical treatment, and discussions of pathological effects of photodynamic action in domestic animals, and in man.

The monograph opens with an introduction to elementary principles of photochemistry, and a discussion of the general biological effects of radiation. The author has paid particular attention to the relation between the absorption spectra of photosensitive or photosensitizing substances and their "action spectra"—the relative effectiveness of various wave lengths in eliciting their biological effects.

A simple example of photodynamic action—such as the photodynamic lysis of red blood cells stained with fluorescein dyes—may be analyzed into a typically photochemical primary process, and subsequent "dark" reactions which include the lysis itself. Photodynamic effects are universally dependent upon the presence of oxygen and are irreversible and essentially destructive. They have nothing in common with either normal biological photoprocesses or normal oxidations. They must be distinguished sharply from the biological effects of ultraviolet irradiation, which differ from them qualitatively and do not require oxygen. The notion that certain ultraviolet reactions might be raised into the visible region by photosensitization has so far been disappointed; thus the irradiation with visible light of either stained organisms or mixtures of ergosterol and photodynamic dyes appears to yield no antirachitic products.

Photodynamic action attains its principal biological importance in the field of pathology. More than half of the present monograph is devoted to this phase of the subject. To identify true photodynamic diseases, Dr. Blum sets up three basic postulates: production of the disease with visible radiation alone, isolation of a photosensitizing substance, and demonstration that the absorption spectrum of the latter corresponds with its action spectrum.

Three important photodynamic diseases of stock animals are treated in detail—geeldikkop, a sheep disease of the Karoo veldt, St. John's-wort poisoning (hypericism), and buckwheat poisoning (fagopyrism). The geeldikkop problem has only recently been solved by the beautiful researches of Rimington and Quin. From one of the plants which induce the disease a number of so-called icterogenins have been isolated. These cause jaundice in sheep, apparently by inhibiting the excretion of bile pigments. One of the pigments deposited in the skin in jaundice is phylloerythrin, derived from dietary chlorophyll, and this is the photosensitizing agent.

Dr. Blum's postulates have not yet been completely fulfilled in any human diseases attributed to photodynamic action. The action spectrum of urticaria solare—abnormal sensitivity to blue and violet light—suggests sensitization by a carotenoid complex. Human photosensitization by porphyrins is well authenticated, but the author's researches do not support the common belief that the disease hydroa is of this nature. The participation of visible light in the etiology of pellagra and of skin cancer is still questionable. The mechanism of human sunburn, a response to ultraviolet irradiation, is discussed in detail, principally to distinguish it from true photodynamic action.

The book closes with a bibliography of about one thousand references.

GEORGE WALD

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April 10, 1941–May 10, 1941

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