mins did not reverse the activity of chlortetracycline at varying concentrations. The metabolite does not affect the antibiotic activity of these compounds, as determined by the standard antibiotic assay technique.

It is interesting to note that while 2,4-dinitrophenol (5×10^{-4} *M*) also inhibits the reaction[2,3] the action of this uncoupling agent[11] is not reversed by the PABA metabolite. These data suggest that different inhibitors of oxidative phosphorylation do not necessarily effect the same locus in the enzyme complex. Witter, Newcomb and Stotz[12] have previously discussed this concept.

The compound designated PABA-metabolite was obtained as a crystalline free base from culture filtrates of *M. smegmatis* which was grown in the presence of 0.1% PABA. The compound was purified by partition between water and ethyl acetate (*p*H 10.0) after removal of the silver precipitable material from the culture filtrate at *p*H 7. The metabolite (ethyl acetate soluble at *p*H 10) was crystallized from water (*p*H 6.8) and then from ethyl acetate, chloroform–petroleum ether mixtures or hot methanol to constant analyses. The yield of recrystallized metabolite is in the order of 500 μg. per liter. The compound has the empirical formula $C_{14}H_{14}N_2 \cdot 1/2H_2O$[13] and melts[14] at 198–199° uncor., with darkening.

Anal. Calcd. for $C_{14}H_{14}N_2 \cdot 1/2H_2O$: C, 76.69; H, 6.90; N, 12.78; mol. wt., 219. Found:[15] C, 76.96; H, 7.23; N, 12.81; mol. wt., 248 (Signer, 10^{-3} *M* in acetone).

The ultraviolet absorption spectrum of the metabolite (free base) in ethanol shows maxima at 258 mμ (ε 23,400) and at 295 mμ (ε 3900). The ultraviolet absorption spectrum of the hydrochloride in ethanol shows a marked change, the absorption peaks at 258 and 295 mμ are replaced by an inflection at 255 mμ (ε 3600). The metabolite shows one aromatic amine group by Bratton–Marshall test[16] per mole (slow development of the color).

The major infrared bands are at 2.9, 6.14, 6.54, 7.07, 7.57, 7.96, 8.45, 8.91, 9.27, 10.03 (broad), 10.67, 11.45, 12.25 and 13.25 microns. Work is now in progress for the elucidation of the structure of this compound.

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[11] W. Loomis and F. Lipmann, *J. Biol. Chem.*, **173**, 827 (1948).

[12] R. F. Witter, E. H. Newcomb and E. Stotz, *ibid.*, **202**, 291 (1953).

[13] Microanalyses were performed by Mr. Louis Brancone and coworkers.

[14] The compound decomposes if heated slowly; a sharp melting point is obtained if compound is placed in preheated bath in vacuum capillary.

[15] Analyses of five preparations agreed.

[16] A. C. Bratton and E. K. Marshall, *J. Biol. Chem.*, **128**, 537 (1939).

LEDERLE LABORATORIES DIVISION
AMERICAN CYANAMID COMPANY
PEARL RIVER, NEW YORK
NATHAN H. SLOANE

RECEIVED OCTOBER 28, 1953

BOOK REVIEWS

Physical Chemistry of Metals. By LAWRENCE S. DARKEN, Ph.D., Research Laboratory, United States Steel Corporation; and ROBERT W. GURRY, Ph.D., Research Laboratory, United States Steel Corporation; with a collection of problems by MICHAEL B. BEVER, Sc.D., Department of Metallurgy, Massachusetts Institute of Technology. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y. 1953. ix + 535 pp. 16.5 × 23.5 cm. Price, $8.50.

This book will appeal to both the chemist and the metallurgist although it was written expressly for the latter. As a text for students who have completed the usual one-year introductory course in physical chemistry, it should find its place in many metallurgy curricula. It will be a valuable guide to the research worker in this field of applied physical chemistry.

After a brief introductory chapter the next four, approximately one-fourth of the book, are devoted to gases, solids and liquids. The discussion of atomic structure is excessively brief but contains a complete table of arrangement of orbital electrons. Bonding and resonance phenomena are treated briefly but competently. In addition the chapter on solids discusses plastic deformation, Hume-Rothery's classification, atomic radii and crystallography of the elements and imperfections in crystals. It contains a rather full exposition of Pauling's theory of valence and atomic radius in metals.

The chapter on solid solutions and intermetallic compounds includes quantitative discussions of the effect of size factor and electronegativity on extent of solid solubility. Long and short range order and intermediate phases are discussed.

Chapter 5 contains an excellent summary of the structure of liquids as deduced from X-ray diffraction data. The authors make a strong case for ordering in certain liquid metallic solutions. A discussion of the "hole" theory of liquid structure contains the only mention of viscosity.

Chapters 6–10 present the classical approach to thermodynamics with applications to metallic solutions and other systems of especial metallurgical interest. Statistical mechanics is considered beyond the scope of the book but its conclusions are used freely, especially in connection with the third law. This procedure is likely to prove baffling to the student who has not been told about the relation between entropy and randomness.

The treatment of solutions will be especially helpful to research metallurgists. The authors employ the function $\alpha_i = \ln \gamma_i/(1 - N_i)^2$ which is useful in interpolating activity data and in graphical integration of the Gibbs–Duhem equation. This chapter and a later one on free energy–composition diagrams are especially recommended to the physicist or metallurgist who is unfamiliar with the elegant methods developed by chemists for the thermodynamic treatment of solutions.

Two chapters on the phase rule and heterogeneous equilibria contain the basic principles applicable to one- and two-component systems. Systems of three or more components are not discussed.

Chapter 14 contains summaries of many useful metallurgical data on the free energy of formation of oxides, sulfides, carbides, nitrides and chlorides. In it also is found a brief summary of the authors' own fine work on the system iron–oxygen. The two following chapters are treatises on the two important systems Fe–N and Fe–C. They include extensive and critical reviews of the literature and collations of the quantitative data available.

Chapter 18, "Formal Basis of Diffusion Theory," has already found its honored place in metallurgical literature. This is more than a routine exposition of the mathematical treatment of diffusion data. It includes a full discussion of the "Kirkendall effect," limitations on Fick's law imposed by grain boundaries and lattice defects, and variations of diffusivity with composition or with chemical potential.

The final chapter, "Kinetics of Metallurgical Processes," is an adaptation of a similar chapter in *Basic Open Hearth Steelmaking* (A.I.M.E., 1951). It contains the most compact and understandable exposition of modern rate theory this reviewer has seen. Applications include the few metallurgical reactions on which adequate rate data have been published.

The usefulness of the book could have been enhanced by addition of a section on strain energy and of a chapter on thermodynamics of surfaces.

The book contains a collection of 257 problems which contribute greatly to its usefulness as a classroom text. The problems are chiefly of a quantitative nature, requiring numerical or graphical solution and most of them demand a substantial amount of original thinking on the part of the student. It would have been helpful to many if answers to a few of the problems had been provided. It seems good educational practice in a book of this sort to put the practical applications in the problems. This has been done in an admirable manner.

From the standpoint of the teacher it is not easy to judge the suitability of a new book until it has been tried in the classroom. The book seems to be a very close approximation to the specialized requirements of a modern curriculum in metallurgy. For a course in thermodynamics Chapters 1, 6 to 14, inclusive, and 17 provide an excellent base. The book will prove stimulating to the advanced student (senior or graduate) and challenging to the teacher. The latter should be prepared to supplement it with respect to several topics which the authors have omitted.

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Data for X-Ray Analysis. Volume I—**Charts for Solution of Bragg's Equation.** By W. Parrish and B. W. Irwin, Philips Laboratories, Inc., Irvington-on-Hudson, N. Y. North American Philips Co., Inc., Research and Control Instruments Division, 750 S. Fulton Avenue, Mount Vernon, N. Y. 1953. v + 100 pp. 21.5 × 30 cm. Price, $2.00.

Data for X-Ray Analysis. Volume II—**Tables for Computing the Lattice Constant of Cubic Crystals.** By W. Parrish, M. G. Ekstein and B. W. Irwin, Philips Laboratories Inc., Irvington-on-Hudson, N. Y. North American Philips Co., Inc., Research and Control Instruments Division, 750 S. Fulton Avenue, Mount Vernon, N. Y. 1953. v + 83 pp. 21.5 × 30 cm. Price, $2.00.

These volumes are announced as the first of a series planned to simplify X-ray crystallographic analysis by providing convenient tables and charts dealing with specialized subjects, supplementing data given in the International Tables for X-Ray Crystallography, the Charts for X-Ray Crystallography, and other existing publications. W. Parrish of the Phillips Laboratories, Inc., is acting as editor of the series.

Volume I consists of 85 graphs in which the spacing d is plotted against the diffraction angle θ for $K\alpha_1$ and $K\alpha_2$ (also $K\alpha$) radiations from molybdenum, copper, cobalt, iron and chromium. $K\alpha$ is given over the range 3 to 45°, $K\alpha_1$ and $K\alpha_2$ from 20 to 85° (40° upper limit for Mo). d spacings are given in ångström units and are based on characteristic wave lengths as published by Bragg (*J. Sci. Inst.*, 24, 27 (1947)). θ can be read directly to 0.01°, giving d directly to 0.01 Å. between 3 and 20°, to 0.001 Å. at higher angles. A table converting minutes into decimal portions of a degree is included.

References to published data of a similar type are given. These graphs permit rapid determination of spacings with a greater accuracy than possible with previously published charts. They will be very useful for identification work if the accuracy indicated is sufficient.

Volume II consists of tables designed to aid the computation of the lattice constant of cubic crystals, giving values of $\sqrt{N} \times \lambda/2$ in ångström units ($N = h^2 + k^2 + l^2$) to six decimal places for $K\alpha_1$, $K\alpha_2$ and $K\beta$ radiations of copper, nickel, cobalt, iron and chromium. (N values cover the range from unity to 378, 326, 281, 241, 158, respectively, for these radiations; the various combinations of *hkl* leading to a given N are included.) To facilitate extrapolation procedures used in high-precision determinations of a, tables of $\sin^2 \theta$ (taken from the International Tables) and $^1/_2((\cos^2 \theta/\sin \theta) + (\cos^2 \theta/\theta))$ (taken from J. B. Nelson and D. P. Riley, *Proc. Phys. Soc.*, **57**, 160 (1945)), are given. L. K. Frevel's tabulation (*Ind. Eng. Chem., Anal. Ed.*, 14, 687 (1942)) of the lattice constants of 705 cubic (and some pseudo-cubic) substances is included, with figures giving a graphical representation of powder patterns of typical cubic crystals.

While the binding of these volumes is not very durable (boards), the tables and charts are printed on a high quality paper with generous spacing giving excellent readability. A convenient indexing system has been used. For those frequently encountering the subjects concerned, these compilations will constitute a valuable reference and aid.

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An Annotated Bibliography of Selected References on the Solid-State Reactions of the Uranium Oxides. By S. M. Lang. National Bureau of Standards Circular 535, Issued January 9, 1953. For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. iv + 95 pp. 15 × 23 cm. Price, 30 cents.

This bibliography contains 257 abstracted references and *ca.* 100 not abstracted. The latter are, unfortunately, not covered in the author index, although they appear to cover relevant material. The booklet was, according to the author, compiled for the Porcelain and Pottery Section of the National Bureau of Standards in connection with work on uranium containing ceramics. The abstracts are not critical and, in general, cover only those parts of the papers which are of interest to ceramicists. The usefulness of the booklet for those interested in the chemistry of uranium in general is thus limited, although it covers adequately the literature in the field for which it was intended. As stated in the Foreword, this circular does not supplant other more extensive annotated bibliographies, such as that of Croxton ("Uranium and Its Compounds," AEC Report No. K-295, Part 2, (1951)) or the book, "The Chemistry of Uranium," by Katz and Rabinowitch (McGraw-Hill Book Co., 1951). The bibliography by Lang may be preferred by people in the ceramics and allied fields because of its compactness and more recent issue date.

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Ionic Processes in Solution. By Ronald W. Gurney, Ph.D. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y. 1953. ix + 275 pp. 16.5 × 23.5 cm. Price $6.50.

This book is interesting because it throws new light on some aspects of electrolyte solutions which until recently have been somewhat neglected. The principal objective of the author is the interpretation of solubility, electrolytic dissociation, ionization potentials and proton transfer reactions by means of a thorough discussion of energy and entropy of a charging process in a dielectric and of configurational entropy. The interpretation is based to a considerable extent on unpublished work of the author. Attention is concentrated on relations between properties of various solutes in various solvents at high dilution. Dependence on concentration, which so often has been the center of attention, is only briefly and incompletely discussed. Knowledge of elementary thermodynamics and of the theory of Debye and Hückel is presupposed.

Literature references are given for the experimental data used but hardly for theoretical results. Even pioneering work such as the paper on electrostriction by Drude and Nernst (*Z. physik. Chem.*, **75**, 79 (1894)) or the Born–Fajans cycle or Koenigsberger's paper (*Ann. Physik*, [4] **5**, 113 (1901)) is not mentioned.

The author's method of presentation invites some general comments. Nowadays a standard method of presenting physical or physico-chemical subjects has been fairly generally adopted. At first basic concepts and assumptions are discussed, then thinking is switched off and the pencil takes over for algebraic and numerical calculation, and finally the significance of the results is contemplated. The method has its pitfalls. Often enough the teacher does not fully explain, or the student does not carefully consider the concepts introduced and the result is a catastrophic lack of understanding.

The author, though refraining from any general comment, obviously has felt the shortcomings of the standard method more strongly than anybody else. He spends an extreme effort on keeping the actual meaning of all quantities introduced before the eyes of the reader in every single calculation step. He adheres to Boltzmann's famous precept to leave questions of elegance to the tailors and shoemakers.

A book written in this vein is useful as a corrective and as a warning against abuse of the standard method. It also demonstrates, by contrast, the great efficiency of the standard method. Anyhow, a deviation may be justified in the author's topic since it focuses in one of the most easily abused concepts, that of the reference state.

Very few mistakes have been noticed (Replace 25300 and 20000 cal./mole by 2500 and 2100 cal./mole, 9 e.u. by 1 e.u. on p. 200. Replace Jamoch by Jamöck on p. 227 and p. 270, $FeClO_4$ by $Fe(ClO_4)_3$ on p. 158).

The specialist will find a number of important and stimulating conclusions, including comments on the ionic radius. It is with sincere regret that we recently learned the news of the premature death of the author. His work is the expression of an independent, original and productive thinker.

SHELL DEVELOPMENT COMPANY
EMERYVILLE, CALIFORNIA
OTTO REDLICH

Structure and Mechanism in Organic Chemistry. BY C. K. INGOLD, Professor of Chemistry, University College, University of London. Cornell University Press, 124 Roberts Place, Ithaca, New York. 1953. vii + 828 pp. 17 × 24.5 cm. Price, $9.75.

It is a very considerable event when the acknowledged leader of the modern developments in reaction mechanisms and structure theories of organic compounds produces a more than 800-page book which draws on the experience of 30 years of extraordinary productivity. Despite the broad title, the work is largely devoted to the contributions of the author and his co-workers and as such constitutes a very valuable bibliography of their papers as well as a complete restatement of their views as of the date of publication. With this scope, it is no surprise that polar or heterolytic reactions are considered to the exclusion of free radical or homolytic reactions.

The book begins with a discussion of valence and physical properties of molecules. This section includes a complete exposition of the electron displacement effects developed by Lucas, Ingold and Robinson between 1925 and 1930. No account is given of the work of Mulliken, Coulson, Longuet-Higgins and Dewar which has led to the current popularization of the molecular orbital approach to organic structural problems. The major part of the book covers two subjects to which the author is the ranking contributor, namely, electrophilic reactions of unsaturated systems and the reactions which occur in and are concomitant with nucleophilic aliphatic substitution. Not only is the current status of each of these topics presented but also the line of historical development is traced. These discussions will be valuable for orientation of future research workers in the fields except where the emphasis on the author's own ideas and experiments is such as to give an incomplete if not distorted perspective. The balance of the book is devoted largely to discussions of nucleophilic reactions of unsaturated systems, including excellent sections on ester hydrolysis and the factors influencing acid–base equilibria. Generally, the approach and subject matter are quite complementary to those of Hammett ("Physical Organic Chemistry," McGraw–Hill Book Co., 1941).

Although the author writes with experience and authority, his style may arouse some measure of controversy. The privilege of writing solely from one point of view has been assumed and past dissenters are dealt with firmly and neatly, although occasionally with intuitive rather than logical arguments. The nomenclature and notation of the book have been employed by the author for many years, and while these will be easily understood, they are not very fashionable in America, particularly *mesomerism* and the indication of hybrid structures by curved arrows. The format is uncrowded and attractive, but unfortunately there are a number of typographical errors, mostly in the references.

In the opinion of the reviewer there can be no question that this is one of the few great books of organic chemistry. It is highly recommended to students and research workers as a fascinating account of modern organic chemical theory and as a guide for solution of new structural and mechanistic problems in all branches of chemistry.

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Papierchromatographie. BY FRIEDRICH CRAMER. Verlag Chemie, GMBH, Weinheim/Bergstr., Hauptstr. 127, West Germany. 1953. 136 pp. 26 × 23 cm. Price, Halbleinen DM 12.80.

The present text is a second and enlarged edition for Monograph No. 64 of "Angewandte Chemie" and "Chemie-Ingenieur-Technik." This small book is primarily a laboratory manual with a minimum of theoretical background. The various techniques and apparatus are adequately detailed for ascending and descending methods, circular filter paper chromatography, also two dimensional methods. The quantitative methods include spot area determination, photometric methods, autoradiography, elution and retention analysis. Preparative paper chromatography using cellulose piles and also paper electrophoresis are briefly considered. About three-quarters of the book is devoted to a fairly detailed consideration of the detection and quantitative estimation of such substances as the amino acids, proteins, sugars, alcohols, phosphoric acid esters, purines, phenols, organic acids and bases, vitamins, steroids and synthetic dye-stuffs. Finally reversed phase and inorganic chromatography are considered. The text is well illustrated with diagrams, has several colored plates, and includes an adequate bibliography. Also two transparent charts are furnished, one for the graphical determination of R_f values of sugars, and one for the detection of amino acids on a two-dimensional chromatogram.

This enlarged edition will undoubtedly be found of value to those working in this rapidly growing field.

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Applied Inorganic Analysis with Special Reference to the Analysis of Metals, Minerals, and Rocks. Second Edition. By the late W. F. HILLEBRAND, the late G. E. F. LUNDELL, late Chief, Chemistry Division, H. A. BRIGHT, M.S., Chief, Analytical Chemistry Section, and J. I. HOFFMAN, Assistant Chief, Chemistry Division, National Bureau of Standards. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. 1953. xxii + 1034 pp. 16 × 23.5 cm. Price, $15.00.

The reviewer welcomed the appearance of the second edition of this book since the first edition and Noyes and Bray's Qualitative Analysis for the Rare Elements have been two sources to which he has been able to send his students with some assurance that the statements found would be supported by sufficient experimental detail for an evaluation of the controlling conditions and the magnitude of the effect. The present authors have maintained the limited objectives of the first edition and state "that this is not a book of special techniques but one devoted primarily to separations and reactions that are fundamental in analytical chemistry." The picture of frustration presented by the young chemist upon resorting to the literature in an effort to carry out his first analysis of other than the idealized quantitative "sample" is adequate evidence of the need for such a book. The extent to which this book has been restricted to these limits is evidenced by the fact that instrumental and physico-chemical methods are covered in about 14 pages, the authors stating: "It is hoped that the brief discussions given will serve to show the usefulness and possibility of application of these techniques if a question of their employment arises."

Significant new material has been added to many of the chapters and those on columbium and tantalum, tin, and the platinum elements have been rewritten. Few errors have been noted. Physical chemists may quibble with the statement that solutions passed through the silver reductor "must be free from platinum salts, for these are reduced to platinum, which, in turn, forms a platinum-silver couple of higher reducing potential . . ." The reviewer would have preferred a critical discussion of homogeneous precipitations and of the benzoate–benzoic acid buffer system instead of the several pages devoted to the Brunck–Funk and Mittasch modifications of the basic acetate procedure. In addition, although extensive use is made of gravimetric procedures there is no mention of the recent work of Duval with the thermobalance.

These are minor points; this is an excellent and valuable book and the revising authors deserve the thanks of analytical chemists for keeping it in print.

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Microwave Spectroscopy. BY WALTER GORDY, Professor of Physics, Duke University; WILLIAM V. SMITH, Professor of Physics, Chairman of the Physics Department, University of Delaware; and RALPH F. TRAMBARULO, Assistant Professor of Physics, Pennsylvania State College. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. 1953. xii + 446 pp. 16 × 23.5 cm. Price, $8.00.

The opening up of a whole new region of the electromagnetic spectrum for spectroscopic purposes is one of the more exciting developments of post-war science. Equipment developed for radar use made it possible to carry out precise measurements on line spectra of polar gases with wave lengths of the order of a centimeter. Many scientists entered the field and the resulting rapid exploitation of the somewhat fabulous new domain had many aspects of a race.

The group at Duke University has played a leading part in this activity, particularly in the opening up of the region of millimeter waves. The present book, from three members of this group, is the first to be published on this subject and serves admirably to provide a broad survey of the whole subject, from experimental methods and theory to applications and results.

The authors cover the following topics: experimental methods, types of microwave spectra in gases, Stark and Zeeman effects, line shapes and intensities, spectra of solids and liquids (paramagnetic and ferromagnetic resonance, nuclear quadrupole resonance), nuclear properties (spins, quadrupole moments, magnetic moments, masses), electrical properties of molecules, molecular structures, applications in other fields. As is inevitable with such broad coverage, many of the theoretical results are not derived but the references to the literature are very complete. In fact the book should be a most useful guide to what has been done in the whole field. It has an adequate index and what appears to be a complete bibliography of the subject, arranged alphabetically within each year. There are also numerous tables: isotopic abundances, masses, moments and spins, various results such as molecular structures and dipole moments, energies of quadrupole hyperfine structures etc.

Besides treating the absorption of microwaves by gases, there is also a chapter on solids and liquids dealing primarily with the subject of paramagnetic resonance, *i.e.*, the absorption of microwaves or radio waves by paramagnetic crystals in a magnetic field. This is a subject perhaps not too closely connected with the material in the rest of the book.

Altogether this book should prove most useful to the reader wishing to learn about microwave spectroscopy and to the research worker in the field who wants a summary of what has been done in each area together with complete references to the literature.

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