

under some continuous group provides one of those all-too-rare revelations which is probably as close to a religious experience as one encounters in science, but this beautiful generalization is not mentioned. By contrast, the Legendre differential equation, while admittedly essential, is comparatively uninspiring. The emphasis on mathematical isomorphism often obscures the physical continuity, and still does not prevent some subjects from recurring in several places (*viz.*, Legendre polynomials). Against the fact that most important proofs are given, it is regrettable that a proof of the Fourier Integral Theorem, such as MacRobert's, which requires only half a page, was not included.

The amount of space devoted to quantum mechanics seems out of proportion, especially relative to that allotted statistical mechanics. Chemists will be dissatisfied that no molecules more complicated than hydrogen are treated, while physicists will miss a discussion of the most fundamental subject of scattering. The authors' hope that this hundred page chapter, supplemented by two or three others, would serve as a text in quantum mechanics courses is probably seldom realized. In the chapter on statistical mechanics, no mention is made of the grand ensemble and its associated partition function, although several pages are devoted to the method of Darwin and Fowler. Indeed, one might wonder why quantum mechanics and statistical mechanics have been singled out for special treatment of their physical, rather than mathematical, content.

Especially noticeable is the omission of any discussion of nonlinear differential equations, particularly those of hydrodynamics and electrodynamics. One might have expected to find these latter subjects also treated under vectors, which find their most elegant applications there. In the discussion of statistics, no mention is made of the extremely useful central limit theorem and its applications. The treatments of the Dirac δ -function and of Green's functions are altogether too brief considering the frequency with which these are met in current literature.

The chapter on matrices, a nice example of lucid condensation, is, however, concerned exclusively with matrices of finite order, for which the basic equation of matrix mechanics, $PQ - QP = h/i$, cannot hold. Incidentally, the statement concerning matrices which commute with a diagonal matrix has been corrected in the second edition, although the error persists concerning the invariance of the trace of a product with respect to permutation of factors (no restriction being made to cyclic permutations).

In summary, this reviewer feels that the greatest shortcoming of the exposition lies in its conventionality, which leads to a lack of portability. There are few points at which the reader feels the subject has been encapsulated for easy retention. As an illustration, the rather complete treatment of the thermodynamic relations culminates in Bridgman's table. Like a table of integrals, this is indeed useful; but how much more useful is a simple four-step rule, such as that of Carroll and Lehrman, which emancipates the student from reliance on a handbook.

Considering the doughnut, the hole represented by these criticisms is comparatively small. The second edition will undoubtedly continue to enjoy the success of the first. It is printed on somewhat better quality paper and, at 1.13 cents per page, is a bargain in today's technical book market.

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Reduction with Complex Metal Hydrides. By NORMAN G. GAYLORD, Interchemical Corporation, New York, N. Y., Interscience Publishers, Inc., 250 Fifth Avenue, New York 1, N. Y. 1956. xvi + 1046 pp. 16 X 23.5 cm. Price, \$15.00.

The reduction of thirty organic compounds by lithium aluminum hydride was reported in 1946. Today more than eight thousand compounds have been reduced by hydride reagents. Thus, it is apparent the complex metal hydrides have found extensive and important applications as synthetic tools in the selective reduction of various functional groups.

The book consists of 1,046 pages which includes the text, ninety-eight tables, literature and patent references, and the index. The coverage of the literature includes "Chemical Abstracts" as well as a page-by-page examination of thirty journals from 1947 up to January 1953. In addition, a few later references have been included.

Reductions of inorganic and organic compounds by lithium aluminum hydride, aluminum hydride, magnesium aluminum hydride, zinc aluminum hydride, lithium gallium hydride, sodium borohydride, potassium borohydride, lithium borohydride, sodium trimethoxyborohydride and other hydrides are described.

Arrangement of material is based on the reactions of functional groups. Much of the presentation is factual copy of published work which includes the preparation and properties of complex metal hydrides, the reaction with inorganic reactants, reactions with organic derivatives of inorganic reactants, the use of complex metal hydrides as analytical reagents, the mechanism of reduction of organic compounds by complex metal hydrides, the reduction of oxygen-, nitrogen-, sulfur- and halogen-containing organic compounds, the reduction of carbon-carbon multiple bonds, miscellaneous reactions such as the Ziegler olefin polymerization, and experimental conditions for carrying out hydride reductions on a laboratory and commercial scale.

The author well demonstrates his acquaintance with the field of hydride reactions. Some topics are given critical review. These include the mechanism of reduction, the cleavage of the C-O bond in amides, and the cleavage of the

$\begin{array}{c} | \\ -N-C-O- \\ | \end{array}$ and $\begin{array}{c} | \\ -N-C-S- \\ | \end{array}$ linkages by lithium aluminum

hydride. Also, wherever possible he presents a correlation of so far unrelated works with conclusions based thereon.

The text is well written and presented but the indexing leaves much to be desired. For example, aminoalcohols can be prepared by reduction of fifteen different types of starting materials, but this information can be obtained only by paging through the book. Although the continuing growth of hydride chemistry, especially in the field of "tailor-made" hydrides for selective reductions, has made this book somewhat less valuable, all chemists should benefit tremendously from this stimulating and excellent monograph on hydride reductions.

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Proceedings of the Sixth Meeting of the International Committee for Electrochemical Thermodynamics and Kinetics.

By G. VALENSI, Editor-in-Chief, Poitiers, France. Butterworths Scientific Publications, 88 Kingsway, London, W. C. 2, England. 1955. xvi + 567 pp. 17 X 23 cm. Price, 84s.

This volume contains over 50 papers presented at Royau-mont and Poitiers in September, 1954, by representatives of fifteen nations. The wide range in subject matter covered in this informative collection makes it a valuable addition to the libraries of a variety of institutions and individual scientists. It also makes it impractical to attempt critical reviews of so many somewhat disconnected topics.

A small but important part is devoted to fundamental principles. The Report of Commission 2, covering 27 pages of parallel texts in French and English, should be studied in connection with earlier recommendations in *Z. Elektrochem.*, 58, 530 (1954), and is the result of painstaking attempts, on an international basis, to bring logical uniformity into the nomenclature and definitions of electrochemistry. The members of this commission are P. Van Rysseberghe (Oregon) chairman, J. O'M. Bockris (Pennsylvania) formerly of London, R. Defay (Brussels), G. Valensi (Poitiers), and R. Piontelli (Milan) *ex officio*. This report is followed by two papers by E. Lange on the description of mixtures and derived quantities of material. G. Valensi formalizes the distinction between electrovalency and oxidation number, and K. Nagel discusses the definitions of polarization and overvoltage. Some controversial aspects of single electrode potentials receive attention in a study of the temperature coefficients of half cells by M. Bonnetay and a note on electrocapillary curves by G. and E. Darmais.

A short section devoted to experimental methods in electrochemistry contains a progress report of Commission 3 charged with this subject, observations on the use of rotating electrodes by H. V. K. Udupa and B. B. Dey, a note on

the use of electrolytic polishing in studying the mechanism of electrolysis and the valence of ions by I. Epelboin, and an article by M. Haissinsky on applications of radioactive methods to the study of surface states and surface reactions.

A section devoted to potential- ρ H diagrams contains a progress report of Commission 1 by M. Pourbaix, and eight papers containing potential- ρ H diagrams for the following metals, or systems, at 25°: Fe, Cd, Co, and the systems Fe-CO₂-H₂O and CN-H₂O by E. Delombe and M. Pourbaix, the systems Ti-H₂O by J. Schmets and M. Pourbaix and Mn-H₂O by A. M. Moussard, J. Brenet, F. Jolas, M. Pourbaix and J. Van Muylder, and the electrode Pt, S/S₆²⁻ at 20 and 25° by G. Maronny and G. Valensi. These are followed by ten articles under the heading polarization curves and electrochemical kinetics. One of these on the temperature dependence of the activation energy of electrochemical reactions, by F. Gutmann and L. M. Simons, is theoretical. The remaining nine contain original experimental data, or curves. B. E. Conway, J. O'M. Bockris and B. Lovreček report the effects of alkaloids on the rate of evolution of H₂ at cathodes of Hg and other metals. H. J. Reiser and H. Fischer present polarization-current curves for the simultaneous deposition of H₂ and Ni, and conclude that the rate-determining stage in H₂-deposition is the recombination of H to H₂, catalyzed by Ni. H. Fisher, M. Seipt and G. Morlock make an oscillographic study of the polarization of the deposition of Ni by measuring the variation in overpotential during short rectangular current pulses. G. B. Adams, M. Maraghini and P. Van Rysselberghe describe methods for measuring the thickness of very thin growing films of ZrO₂. These methods should be serviceable in studying the effects of numerous variables upon the ionic current responsible for oxide film growth. Activation polarization in the electrodeposition of Cu is studied by E. Mattsson and R. Lindström, and they explain why the rate-determining step in the deposition depends upon current density. L. Gierst and L. Bourgeois present experimental curves and survey the kinetics of the passivation of Hg, and A. Ruis, J. Llopis and F. Colom do this for the effects of alternating current on the overpotential of O₂ and some anodic oxidation processes. This section is concluded with short papers concerning the electrolysis of NaCl with a mercury cathode. M. Dodero and M. Behroun discuss the copious evolution of H₂, and M. Dodero, C. Deportes and R. Mayoud present the potential- ρ H diagram and polarization curves for the electrolysis.

The last half of the book is concerned with practical applications of electrochemical thermodynamics and kinetics, and with polarography. Nine papers deal with corrosion. This subject is introduced with a statement of the aims of the study group on corrosion, and with a discussion of definitions, classifications and nomenclature used in the description of corrosion-inhibition and inhibitors. The careful experimental work of A. Ruis, J. Llopis and F. Colom on superimposed alternating currents is extended to the anodic corrosion of Pt. R. Olivier contributes a long and important paper on the passivity of Fe-Cr alloys, including 18/8 stainless steel. J. Van Muylder and M. Pourbaix present two papers on the electrochemical behavior of lead and its corrosion and cathodic corrosion protection, and A. M. Abd El Wahed and M. Pourbaix explain the use of polarization curves in studying the corrosion and protection of Fe in the presence of chlorides. M. Serra and S. Feliu present data on the anodic passivation of Fe in sulfate solutions, and discuss several processes which can explain its origin. M. Billy and G. Valensi report an interesting and careful kinetic study of the formation of β -silver sulfide, and discuss its bearing upon the phenomenon of electrochemical corrosion. The electrochemistry of Mn is emphasized in papers under the supervision of Study Group 2 concerned with batteries and accumulators. K. H. Maxwell and H. R. Thirsk contribute an exhaustive study of the relation between preparation and structure of MnO₂ and the e.m.f. of cells containing the MnO₂ electrode. An interesting controversy results from the juxtaposition of a paper on the thermodynamics of the MnO₂ electrode by J. Brenet and a paper by the same author and A. M. Mousard on the variability of the potential of this electrode in practice.

The applications of polarography to analytical chemistry are outlined by P. Souchay, and a renewed Hg cathode is shown by H. Coriou, J. Dirian and J. Hure to permit a practical separation of traces of Mn from relatively large

amounts of electrolytes. M. A. El Guebelly shows that this electrode can also be used in the determination of Ru in extremely dilute solutions, because the concentration of Ru is proportional to the velocity of H⁺ ion discharge which it catalyzes. New developments in polarography and voltammetry are reviewed by P. Delahay. The volume is concluded with a collection of important but somewhat unrelated papers. The conditions for electrolytic reduction of salicylic acid are investigated by H. V. K. Udupa and B. B. Dey, and the conditions and mechanism of the electrolytic preparation of cyclobutanol are discussed by R. Le Corff and F. J. Taboury. Two papers are concerned with the mechanism of reduction at the Hg cathodes. The reduction of CO₂ is considered by T. E. Teeter and P. Van Rysselberghe, and H₂O₂ is studied by G. A. Murdock and P. Van Rysselberghe. The mechanism of electrolytic polishing is discussed by S. Feliu and M. Serra. A cryoscopic study is reported by Y. Doucet, who investigated the thermodynamic behavior of mixtures of fused salts.

Although a part of the volume is necessarily devoted to reports and the plans of committees and study groups which may not be of interest to the general reader, some 500 pages contain a wealth and variety of original contributions, and many of these are largely experimental. The International Committee for Electrochemical Thermodynamics and Kinetics is to be congratulated for making the results of such work available in this convenient and well-organized collection.

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BENTON BROOKS OWEN

Electrochemical Affinity. Studies in Electrochemical Thermodynamics and Kinetics. By PIERRE VAN RYSSELBERGHE, Professor at the University of Oregon, Eugene, Oregon. Hermann and Cie, Editeurs, 6 Rue de la Sorbonne, Paris 6, France. 1955. 109 pp. 16 × 24 cm. Price, 1250 French francs.

The theme of this booklet is "that a rational treatment of electrochemistry requires the use of the thermodynamics of irreversible processes and that this discipline, although not new by any means, is still unfamiliar to the majority of physical chemists and electrochemists." For this majority it can be stated briefly that the thermodynamics of irreversible processes comprises a generalized description in which reversible processes and equilibria are limiting cases. To the majority this may not appear novel or profound. Nevertheless, the thermodynamics of irreversible processes is a profound subject with much of its modern development based on Onsager's reciprocal relations together with the use of concepts such as the degree of advancement of a reaction and the power of irreversibility introduced by De Donder and extended by Van Rysselberghe.

The topics discussed are limited to the theory of galvanic and electrolytic cells, electrode processes, polarization, overpotential, electrochemical kinetics and thermo-electrochemistry. In essentially the same form a portion of this material has been presented by Van Rysselberghe in the *J. Phys. Chem.* 57, 275 (1953). This article on electrode phenomena and the thermodynamics of irreversible processes exhibits the same scholarship and style so precisely that it can serve as an illustrative review and partial replica of the material in this brief but interesting book.

NATIONAL BUREAU OF STANDARDS

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Blood Group Substances. Their Chemistry and Immunology. By ELVIN A. KABAT, Departments of Microbiology and Neurology, College of Physicians and Surgeons, Columbia University; and Neurological Institute, Presbyterian Hospital, New York. Academic Press, Inc., Publisher, 125 East 23rd Street, New York 10, N. Y. 1956. ix + 330 pp. 16 × 23.5 cm. Price, \$8.00.

The author of this very worthwhile book brings to his task a profound knowledge of immunochemistry and also a long experience in the field in which the A,B,O blood group system forms a useful model. Much of present day knowledge in immunology and chemistry of antigens and antibodies has been obtained by study of this system.