exhibits two very broad bands centered at about 5400 and 6700 Å. In water the compound is rapidly oxidized to rhodizonate ion, $C_6O_6^{-2}$.

The magnetic properties of $C_6O_6^{-4}$ are of especial interest in connection with its electronic structure. Simple LCAO molecular orbital calculations[3] predict a biradical nature for $C_6O_6^{-4}$. However, measurements by the Gouy method show that $K_4C_6O_6$ is diamagnetic. The compound may be one in which electron correlation effects, neglected in the simple MO approach, operate to prevent the degeneracy. Similar arguments have been used to predict a non-degenerate ground state for cyclobutadiene.[4] A complete treatment of $C_6O_6^{-4}$, including configuration interaction, would present a formidable theoretical problem.

Pure $K_4C_6O_6$ gives no electron spin resonance signal, but the compound is rapidly oxidized upon exposure to air, with the development of a strong esr signal. Incomplete oxidation of $K_4C_6O_6$ under ether also converts it to a strongly paramagnetic solid, green in color, with a single electron spin resonance near $g = 2.003$. A similar green salt may be obtained instead of $K_4C_6O_6$ in the preparation described above if a small amount of oxygen is present. Further oxidation converts the green salt to potassium rhodizonate, but samples stored in the absence of oxygen maintain their radical nature almost undiminished for several months. It has not yet proved feasible to prepare this radical substance in pure form, but observations so far are consistent with the hypothesis that the green salt may contain the tripotassium salt of the aromatic radical-trianion, $C_6O_6^{-3}$.

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The rhodizonate anion in the crystalline salts $Na_2C_6O_6$ and $K_2C_6O_6$ appears also to have a non-planar or otherwise distorted geometrical form.

(3) D. L. Powell, M. Ito and R. West, unpublished work.

(4) D. P. Craig, *Proc. Roy. Soc.* (*London*), **A202**, 498 (1950); *cf.* A. D. Liehr, *Z. physik. Chem.*, *N. F.*, **9**, 338 (1956).

BOOK REVIEWS

Some Recent Developments in the Chemistry of Phosphate Esters of Biological Interest. By H. GOBIND KHORANA, Institute for Enzyme Research, University of Wisconsin. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. 1961. ix + 141 pp. 15.5 × 23.5 cm. Price, \$5.25.

This volume derives from a series of lectures given at the Rockefeller Institute in 1959, but is up-dated with many references into 1961. It naturally emphasizes the author's interests but is an essential for those interested in nucleotide and polynucleotide syntheses. The first twelve-page chapter is a survey of phosphate compounds of importance in biological reactions and is certainly worthy of attention by any graduate student.

SLOAN-KETTERING DIVISION OF
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GEORGE BOSWORTH BROWN

The Electrical Double Layer Around a Spherical Colloid Particle. Computation of the Potential, Charge Density, and Free Energy of the Electrical Double Layer Around a Spherical Colloid Particle. By A. L. LOEB, Associate Professor of Electrical Engineering, Massachusetts Institute of Technology, J. TH. G. OVERBEEK, Professor of Physical Chemistry, University of Utrecht, and P. H. WIERSEMA, van't Hoff Laboratory, University of Utrecht. The M.I.T. Press, Massachusetts Institute of Technology, Cambridge, Massachusetts. 1961. 375 pp. 18.5 × 26 cm. Price, \$10.00.

This book reports the numerical integration of the Poisson–Boltzmann equation for spherical colloidal particles in electrolytic solution. Results are presented in terms of reduced (*i.e.*, dimensionless) quantities. First, y (reduced electrostatic potential) is calculated as a function of x (reduced reciprocal distance from center of particle) with y_0 and $q_0 = 1/x_0$ (x_0 and y_0 are values of x and y at particle surface, outer Helmholtz plane, or slipping plane depending on application) as parameters. I_+ and I_- ($x^2/4$ times excess charge due to cation and anion outside of a sphere of reduced radius $1/x$ centered on the particle center) and the reduced double layer free energy F are calculated from the previously calculated dependence of reduced potential on reduced reciprocal distance. Tabular results are given for 1–1, 2–1, 3–1, 1–2 and 1–3 electrolytes; data for other symmetric electrolytes (2–2, 3–3 etc.) can be calculated readily from results for 1–1 electrolytes.

Part I of the book (pp. 1–42) describes the method of integration, including transformations of variables to dimensionless groups, an outline of the numerical integration method selected for IBM-704 computer programming, and an outline of methods for transforming tabular results (all in dimensionless groups) into quantities of physical interest. Results of the present calculation are compared with those of the Debye–Hückel approximate treatment and the flat plate double layer. Empirical analytical forms representing data for I and F to within 26% and 20%, respectively, are also given. Part I contains 28 tables.

Part II (pp. 46–372) presents the dependence of y, I_+, I_-, and F on x with y_0 and q_0 as parameters in tabular form for 1–1, 2–1, 3–1, 1–2 and 1–3 electrolytes. Computations for 1–1 electrolytes are particularly extensive (pp. 46–208); results for $q_0 = 0.1$, for example, are presented for the range $0.3 \leq x \leq 10.0$ in units of 0.1 for $1 \leq y_0 \leq 16$ with increments of 1 from 1–10, 2 from 10 to 16; this is repeated with reduced ranges of x for $q_0 = 0.2, 0.5, 1.0, 2.0, 5.0, 10$ and 20. For values of x smaller than those tabulated the Debye–Hückel approximation is adequate. The authors state that numerical interpolation between tabulated results will generate results accurate to 0.1% if carefully done; linear interpolation between values of x for fixed q_0 and y_0 appears generally possible to within 1%, but interpolation between different values of q_0 and y_0 will require more refined interpolation involving, for example, ratios of tabulated quantities to approximate or empirical analytical representations of them.

This is a specialist's book concerned principally with numerical results. These results appear to be carefully obtained, and to reflect solutions of the Poisson–Boltzmann equation of adequate precision and detail covering a wide range of parameters. The authors point out that the Debye–Hückel approximation to the Poisson–Boltzmann equation is only valid if $Ze\psi/kT << 1$. Applicability of the present results to physical phenomena, however, depends on the validity of the Poisson–Boltzmann equation, and the validity of this equation under conditions where $Ze/kT << 1$ is not satisfied is also open to question (for a review on this point, see H. S. Harned and B. B. Owen, "The Physical Chemistry of Electrolytic Solutions," 3rd Ed., Reinhold Publishing Corp., New York, N.Y., 1958, pp. 57–58).

The general reader will find Overbeek's articles in "Colloid Science," H. R. Kruyt, Ed., Vol. I, Elsevier Publishing Co., New York, N. Y., 1952, a more satisfactory presentation of double layer principles than the present book, which is chiefly tabular in character.

CHEMISTRY DEPARTMENT
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Medicinal Chemistry. Volume V. A Series of Reviews Prepared under the Auspices of the Division of Medicinal Chemistry of the American Chemical Society. WALTER H. HARTUNG, Editor. ERNEST E. CAMPAIGNE, Associate Editor. WARREN J. CLOSE, LEONARD DOUB and MARVIN A. SPIELMAN, Authors. John Wiley and Sons, Inc., 440 Park Avenue South, New York 16, N. Y. 1961. vi + 432 pp. 15.5 × 23.5 cm. Price, $18.00.

The fifth volume of this series covers two subjects, Anticonvulsant Drugs by Warren J. Close and Marvin A. Spielman, and Bis-(4-aminophenyl) Sulfone and Related Compounds in Tuberculosis and Leprosy by Leonard Doub.

For the first chapter, the authors have surveyed 1113 literature references and a large number of domestic and foreign patents up to January 1, 1959. In the 44 pages preceding the tables, the authors discuss the classification of epilepsies, a history of epilepsy and antiepileptic agents, the screening of compounds for anticonvulsant action, the synthetic methods employed in the preparation of the several classes of compounds, the clinical effectiveness of the compounds which have been used therapeutically, their mode of action, distribution and metabolism and structure–activity relationships.

While the reader may acquire from the discussion an understanding of this complex field of therapy, the reviewer feels that the effectiveness of this section is appreciably weakened by the frequent use of rhetorical expressions rather than objective reporting. Several inconsistencies were also noted. The following may be cited as examples. Structure–activity relationships in this field are likened to seeking structure–activity relationships among axes, drills, saws and sandpaper. Again, having carefully distinguished between "anticonvulsant" and "antiepileptic" agents on page 2, the authors frequently use these terms as equivalents during the subsequent discussion. On page 30, acetazoleamide is found clinically to be (a) disappointing, (b) more satisfying or (c) ineffective, yet on page 35, the same compound is "known to be an effective anticonvulsant and antiepileptic agent."

The first chapter is completed with approximately 250 pages of tables in which individual compounds are listed systematically by chemical structure along with their anticonvulsant activities in laboratory animals.

In the second chapter, the author has surveyed approximately 250 selected papers related to or suggestive of the use of bis-(4-aminophenyl) sulfone and related compounds in the treatment of tuberculosis or leprosy. The subjects discussed include methods of synthesis, test procedures, mechanism of action, pharmacology, and sulfones in experimental tuberculosis and leprosy.

Approximately 41 of the 45 pages devoted to tables of individual compounds are concerned with *in vitro* and *in vivo* activities in experimental tuberculosis; 4 pages list the compounds which have been studied in murine and human leprosy.

The discussion covers 21 pages and is a sober and informative review of the field. While the usual small number of minor typographical errors of a first edition were noted, these in no way reflect on the excellence of this chapter.

THE SQUIBB INSTITUTE FOR MEDICAL RESEARCH
NEW BRUNSWICK, NEW JERSEY HARRY L. YALE

Argon, Helium, and the Rare Gases. The Elements of the Helium Group. Volume I. History Occurrence, and Properties. Editor: GERHARD A. COOK, Research Laboratory, Linde Company, Division of Union Carbide Corporation, Tonawanda, New York. Interscience Publishers, Inc., 250 Fifth Avenue, New York 1, N. Y. 1961. xxii + 427 pp. 16 × 23.5 cm. Price, $17.50.

This collection of fundamental data and other information on the inert gases accurately reflects in its makeup the emphasis which has been placed on different areas of inert gas research. Thus three large chapters (200 pages) are devoted to gas phase properties. In one is found an exhaustive compilation of data on solubility, thermal conductivity, viscosity, diffusion and permeation, adsorption, velocity of sound, electrical and magnetic properties, optical properties, and compressibilities. Detailed thermodynamic and spectral data are reserved for separate chapters. Crudely speaking, it is fair to say that a person could find out just about anything he might want to know about gaseous and atomic inert gases somewhere in these three excellent chapters. The only serious omission from the chapter on "Atomic Structure and Spectra," in this reviewer's opinion, is a tabulation or plot of electronic charge densities as they are known from Hartree–Fock and Thomas–Fermi studies.

A seventy-eight page chapter on the liquid and solid inert gases is devoted almost entirely to thermodynamic properties, again reflecting the state of the art. Unfortunately, recent data on optical absorption and refractive indices of the solid rare gases appear to have become available too late for inclusion.

It came as a surprise to this reviewer that the inert gases have "chemical properties," but one sixteen-page chapter is devoted to this interesting topic. There exist weakly bound diatomic molecules such as Xe_2 and HgKr, more strongly bound ions such as Ar_2^+ and NeH^+, and clathrates in which inert gases are caged among host molecules *via* van der Waals forces. It was no surprise that the inert gases participate in nuclear reactions; one thirty-two-page chapter contains excerpts from tables of decay schemes originally published in *Reviews of Modern Physics*, tables of neutron cross sections, and an introduction to nuclear physics which in its elementary pedagogical style departs considerably from the style of the other sections of the volume. This is not to say that the editor's desire to "avoid making the work merely a dry compilation of facts" was not fulfilled. The book is certainly readable throughout.

The material described above is preceded by three introductory chapters including discussions of the genesis, history and procurement of the inert gases. It is followed by a summary, consisting mainly of a two-page table of physical properties, and by extensive name and subject indices. This volume should be of value to anyone with more than a casual acquaintance with the rare gases, but its substantial price will probably confine it to library shelves. A second volume dealing with purification and industrial applications of the inert gases is promised.

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BOOKS RECEIVED

February 10, 1962—March 10, 1962

M. PIERRE BARCHEWITZ. "Spectroscopie Infrarouge." Partie I. "Vibrations Moléculaires." Gauthiers-Villars and Cie, Editeur, 55, Quai des Grands-Augstins, Paris 6, France. 1961. 238 pp. NF. 42.—.

ROBERT G. BREENE, JR. "The Shift and Shape of Spectral Lines." Pergamon Press Ltd., Headington Hill Hall, Oxford, England. 1961. 323 pp. $15.00.