

arated by silicate column chromatography and identified, by melting point and X-ray powder diffraction patterns, as the crystalline, fully acetylated derivatives of isomaltitol,² β -isomaltose,³ D-glucose and D-glucitol. These data identify

(2) M. L. Wolfrom, A. Thompson, A. N. O'Neill and T. T. Galowski, *THIS JOURNAL*, **74**, 1062 (1952).

(3) M. L. Wolfrom, L. W. Georges and I. L. Miller, *ibid.*, **69**, 473 (1947); **71**, 125 (1949).

the trisaccharide as isomaltotriose⁴ and indicate that a part of the α -D-(1 \rightarrow 6) glycosyl linkages exist in adjacent units in glycogen.

DEPARTMENT OF CHEMISTRY
THE OHIO STATE UNIVERSITY
COLUMBUS 10, OHIO

M. L. WOLFROM
A. THOMPSON⁵

(4) Allene Jeanes, C. A. Wilham, R. W. Jones, H. M. Tsuchiya and C. E. Rist, *ibid.*, **75**, 5911 (1953).

(5) Research Associate of the Corn Industries Research Foundation.

RECEIVED JUNE 27, 1956

BOOK REVIEWS

Introduction to Thermodynamics of Irreversible Processes.

By I. PRIGOGINE, D. Sc., Professor, Faculty of Science, University of Brussels, Brussels, Belgium. Charles C. Thomas, Publisher, 301-327 East Lawrence Avenue, Springfield, Illinois. 1955. ix + 155 pp. 14 \times 22 cm. Price, \$4.75

This monograph belongs to a series entitled "American Lectures in Biochemistry and Biophysics" edited by Dr. W. Bladergroen of Delft, the Netherlands, for Sandoz Ltd. of Basle, Switzerland. Having been published simultaneously in the U. S. A. by Charles C. Thomas, in Great Britain by Blackwell Scientific Publications (Oxford), in Canada by the Ryerson Press (Toronto), and its author being on the staff of the University of Brussels, Belgium, this work has a strong international flavor. It is a welcome addition to the still limited "digested" sources of information on the recent developments in the thermodynamics of irreversible processes and it will, in particular, be of definite help to the readers of the author's previous "Etude Thermodynamique des Phénomènes Irréversibles" (Desoer, Liège, Belgium, 1947). Professor Prigogine has been one of the main contributors to this field. As a member of De Donder's school of thermodynamics (see a review by F. O. Koenig, *THIS JOURNAL*, **77**, 6718 (1955)) he brought into complete harmony De Donder's affinity theory and the developments based upon Onsager's linear phenomenological laws and reciprocity relations. From there Professor Prigogine moved on toward a series of brilliant contributions of his own.

The first three chapters constitute a clear condensation of the fundamentals of thermodynamics in the De Donder form, the second principle being presented as that of "entropy production." The section of Chapter III on entropy production due to heat flow, to chemical and electrochemical reactions in closed, open and continuous systems, and the considerations on internal degrees of freedom furnish the transition toward the presentation, in the remaining three chapters, of a detailed study of the general properties of, and relations between rates and affinities, of the linear phenomenological laws, of Onsager's reciprocity relations, etc. Chapter V contains treatments of several important particular cases: chemical reactions near equilibrium, electrokinetic effects and Saxen's relation (the proof of which constitutes one of the main achievements of the thermodynamics of irreversible processes), thermomolecular pressure difference and thermomechanical effect, etc. Chapter VI gives a thorough treatment of stationary non-equilibrium states, of states of minimum entropy production, of stationary state coupling, and finishes with two pages of remarks on applications in biology, a section one would wish to see greatly expanded by someone in the near future. An appendix on non-linear problems, a list of sixty-three references to the literature of the subject (some of them including several titles), a three-page list of notations and a two-page subject index conclude this monograph.

Professors Prigogine and Defay have announced, some time ago already, a more detailed treatment of irreversible processes in a third and last volume of their "Chemical

Thermodynamics." Many workers in a large variety of fields will be waiting with impatience for its publication. In the meantime, the present small volume provides a very readable and clear survey of these fascinating developments.

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF OREGON
EUGENE, OREGON

PIERRE VAN RYSSELBERGHE

Gmelins Handbuch der Anorganischen Chemie. Edited by E. H. ERICH PIETSCH. Verlag Chemie, G. m. b. H., Weinheim/Bergstr., Germany. 17.5 \times 25.5 cm.

This review covers four portions of the 8th Edition, all in the now-familiar style and plan of organization, as follows:

1. *Selen*, Teil A. System-Nummer 10. xvii + 184 pp. Price \$26.64. No. 3 of Part A of the volume on Selenium. Completes Part A. Covers the literature through 1952 on selenium rectifiers (107 pages) and photoelectric cells (75 pages).

2. *Boron*, System-Nummer 13. vii + 253 pp. Price \$34.80 in cloth, \$33.60 in wrappers. This is the complete volume on Boron. Fifty-eight pages deal with occurrences, 38 with preparation and properties of the element and analytical methods, 117 with compounds of boron with elements of "system-numbers" 1-12. The literature is covered through 1949.

3. *Gold*, Part 2. System-Nummer 62. v + 306 pp. Price \$40.32. No. 2 of the volume on Gold. Covers the literature through 1949 on occurrences (178 pp.), ore reduction and extraction (57 pp.), preparation and purification of the metal (11 pp.), special forms including colloidal gold (48 pp.), and surface treatments of the metal and its alloys (6 pp.).

4. *Gold*, Part 3. System-Nummer 62. xxi + 558 pp. Price \$74.88. No. 3 of the volume on Gold. Completes the volume. Covers the literature through 1949 on physical properties (156 pp.), electrochemical behavior (58 pp.), chemical behavior (23 pp.), analytical methods (25 pp.), compounds (113 pp.) and alloys (193 pp.).

NATIONAL BUREAU OF STANDARDS
WASHINGTON, D. C.

EDWARD WICHERS

Cancérisation par les Substances Chimiques et Structure Moléculaire. By ALBERTE PULLMAN, Maître de Recherches au Centre National de la Recherche Scientifique, and BERNARD PULLMAN, Maître de Conférences à la Faculté des Sciences de Paris. Masson et Cie, Editeurs, 120 Boulevard Saint-Germain, Paris VI, France. 1955. 306 pp. 16.5 \times 25 cm. Price, 2.800 Fr.

One of the important developments in recent years in the study of carcinogenesis by polycyclic aromatic compounds has been the attempt to relate carcinogenic activity to electron distribution as calculated by quantum mechanics. This work, which has been carried out mainly by the Pullmans, the Daudels and Coulson, and their collaborators, has been summarized in several places, notably in the various volumes of the "Advances in Cancer Research" series, and it now receives a detailed presentation in the present volume.

The discussion is directed at chemists and biologists, not at quantum mechanicians; the methods of calculation have been described in detail in the same authors' earlier volume, "Les Théories Electronique de la Chimie Organique" (*cf.* THIS JOURNAL, 74, 6158 (1952)), and the presentation in the present volume is entirely non-mathematical.

After description of the basic ideas of the valence bond and molecular orbital methods, the authors review the experimental results on carcinogenic activity in unsubstituted polycyclic aromatic hydrocarbons. It is clear that activity is associated with a bond of the 9,10-phenanthrene type, the so-called K-region, and that the presence of highly reactive positions corresponding to the meso or 9,10-positions of anthracene (the L-region) is unfavorable for carcinogenic activity. The calculations of various parameters relating to electron distribution and polarizability show that carcinogenic activity is almost invariably associated with a bond in the K-region which is very susceptible to electrophilic addition, and with the absence of a reactive L-region. The authors conclude from this that carcinogenesis involves an electrophilic addition of some cell constituent at the K-region, and that this addition is inhibited by the presence of a reactive L-region.

This theory cannot be said to be proved, in view of the almost total lack of knowledge about the mechanism of carcinogenesis, but it does correlate a large number of observations, and has proved to be very stimulating and useful in suggesting experimental work.

The K-region theory is also quite successful in dealing with methyl and methylene derivatives of the parent hydrocarbons, although here the calculations apparently involve even more assumptions and simplifications than with the parent structures. Several observations show that the theory must be regarded as describing a necessary but not sufficient basis for carcinogenic activity; among these are the lack of activity of benzanthracenes with methyl sub-

stitution in the angular ring, and the decreased activity caused by replacement of a methyl group by a larger alkyl group. Neither of these changes affects the electronic distribution in the K and L-regions appreciably.

The calculations as applied to compounds containing substituents other than alkyl groups, to heterocycles, to carcinogenic azo compounds and to stilbenes are more empirical and less satisfactory. It appears that the theory is most useful for the hydrocarbons.

An excellent account is given of the studies on metabolites derived from carcinogens. A detailed discussion of various physical properties of carcinogenic substances shows that there is no satisfactory correlation between any of these and the carcinogenic activity.

Experimentalists may find the tone of the book rather doctrinaire and dogmatic; the treatment of the interaction of free-radicals with polycyclic compounds is especially unsatisfactory. The authors do not seem to have a very strong feeling for the complexities of any biological process, and of the carcinogenic process, in particular, with all of its chemical and biological variables; the possession of a suitable K and L-region in the hydrocarbons, for example, is only one of a great number of properties which may need to be considered.

The generalizations developed by the authors are important, and they have written a valuable book, which will be far more stimulating to future research on carcinogenesis than a more cautious chemical compendium would have been. The material is presented in a clear and elegant style, and the book should be widely read by those interested in the cancer problem.

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF ROCHESTER
ROCHESTER 20, NEW YORK

D. S. TARBELL