wise "Thermodynamik der Irreversiblen Prozesse" is a book that this reviewer wishes he could have written himself. Haase is a master teacher who has given the physical chemist a first-rate introduction to the thermodynamics of irreversible processes. It is to be hoped that the linguistic laziness of the English-speaking world will not impede this book in achieving the high reputation it truly deserves.

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The Chemistry of Cationic Polymerization. Edited by P. H. PLESCH. Pergamon Press, The Macmillan Co., 60 Fifth Ave., New York 11, N. Y. 1964. 728 pp. 16 × 24 cm. Price, $30.00.

The concepts and experimental information available for cationic-catalyzed polymerization have increased in a spectacular fashion in the past twenty years. A specialized book of this kind, consisting of contributed chapters amounting to 712 pages, is an indication of the interest in this general subject.

There is considerable overlap in many of the chapters which the editor has clearly recognized, and rather than disrupt the flavor of a chapter by an expert, he has chosen to allow some duplication and insert comments and cross-references. One could always quarrel with the verbosity of some of the chapters, but it is inevitable in a specialized book of this type.

There are two groups of people to whom this book will be very useful: (1) macromolecular chemists who are interested both in synthesizing large molecules and mechanisms of polymerization; and (2) a small "hard-core" of researchers throughout the world working on the details of mechanisms of catalyzed-cationic polymerization.

The first two chapters

I. "Carbonium Ions," by M. L. Burstall (Battersea College of Technology, London) and F. E. Treloar (University of Malaya)

II. "Organic Reactions Related to Cationic Polymerization," by M. L. Burstall

are background material to review the chemistry of ion pairs in solution. This may have seemed advisable, but this reviewer rather questions whether it has been worthwhile, because by necessity these chapters cover details of intermediates and transition states, etc., which are also discussed by authors in individual chapters. Perhaps this repetition may be helpful to some readers.

The third to eighteenth chapters are listed here for information:

III. "A Comparison of the Radical, Cationic and Anionic Mechanisms of Addition Polymerization," by P. E. M. Allen (University of Birmingham) and P. H. Plesch (University of Keele)

IV. "Isobutene," by P. H. Plesch

V. "Aliphatic Mono-olefins Other Than Isobutene," by C. M. Fontana (Celanese Corporation of America)

VI. "Styrene," by Professor A. R. Mathieson (University of Northern Nigeria)

VII. "Aryl Olefins Other Than Styrene," by S. Bywater (National Research Council, Ottawa)

VIII. "Polyenes," by W. Cooper (Dunlop Rubber Co.)

IX. "Vinyl Ethers," by Professor D. D. Eley (University of Nottingham)

X. "Epoxides," by A. M. Eastham (National Research Council, Ottawa)

XI. "Cyclic Oxygen Compounds Other Than Epoxides," by J. B. Rose (I. C. I. Plastics Division)

XII. "Miscellaneous Oxygen Compounds," by A. Schrage (Rexall Chemical Co.)

XIII. "Sulphur Compounds," by J. Lal (Goodyear Tire and Rubber Co.)

XIV. "Nitrogen Compounds," by G. D. Jones (Dow Chemical Co.)

XV. "Co-polymerization," by R. B. Cundall (University of Nottingham)

XVI. "Cationic Reactions of Polymers and Cationic Graft Polymerization," by Professor G. Smets and M. van Beylen (University of Louvain)

XVII. "Cationic Polymerizations Induced by High Energy Radiation," by S. H. Pinner (BX Plastic Ltd.)

XVIII. "Experimental Techniques," by P. H. Plesch

This reviewer would disagree occasionally with points of view raised, but in a book of this sort this would be unavoidable. Research workers in specific areas of cationic polymerization will want this book as part of their personal library; certainly every macromolecular chemist will need this book for reference referral.

The editor is to be complimented for completion of a difficult task.

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The Rare-Earth Elements. By D. N. TRIFONOV, Institute of the History of Sciences and Technology of the Academy of Sciences of the U.S.S.R. The Macmillan Co., 60 Fifth Ave., New York, N. Y. 1963. xv + 128 pp. 14.5 × 22 cm. Price, $3.50.

It is indeed unfortunate, as the author states, that "the number of review articles and books on the rare-earth elements in Russian is very small." This circumstance has led him to prepare a little volume of facts gleaned from out-of-date Russian works and some, but obviously not all, of the English language reviews of the subject. His intent was to furnish the Russian student of chemistry with "an account which is lively, easily-intelligible and informative, of the long and extremely involved story of the discovery of these elements, their properties, the methods for their separation, the present state of problems regarding them, and some prospects of future developments in this branch of chemistry." The result of Trifonov's abbreviated and cursory interpretation of existing accounts, and a detectable amount of Russian bias in assessing the contributions of the various workers whose names are cited, is extremely disappointing—in that he has fallen miserably short of his stated goal. Only the history of their discovery and the early chemistry of the rare earths have been treated adequately. Modern ion-exchange methods for separating rare earths have been passed over lightly, and solvent extraction techniques have not been discussed at all.

Interpretation and translation of English works to Russian, and literal retranslation of the result to English by an Indian translator, with inadequate final editing, have contributed to the inclusion of an appalling number of typographical errors, obvious mistakes, and garblings of radiochemical symbols.

Owing to the many mistakes, various omissions, perpetuation of many common misconceptions (that the ion-exchange method is unsuitable for producing large quantities of pure rare earth materials, that rare earth elements are extremely difficult to obtain in the metallic state, that the cost of rare earth oxides and metals is prohibitive, that dilute nitric acid acts only on metallic cerium, etc.), and a complete lack of specific references to the source of data cited, this book is not to be recommended—either to the student, whom it will confuse, or to the expert, whom it will disappoint.

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Consecutive Chemical Reactions. By N. M. RODIGUIN and E. N. RODIGUINA. Translated from the Russian by Scripta Technica, Inc. D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J. 1964. ix + 136 pp. 15.5 × 23.5 cm. Price, $5.00.

One day last March, I (= this reviewer) received from Mount Olympus a curiously composed proposal that I review a small book on the mathematical theory of chemical reaction kinetics—by Dr. and Mrs. Rodiguin of Russia—for the American Chemical Society's most celebrated Journal. To have rejected the proposal on any grounds whatever—ideological, temperamental, or financial—would have invited certain persecution by all the gods and the Society too. The last time I was persecuted by the ACS was when I was falsely accused of having taken advantage of one of their "inexperienced" employees, a very pretty Chinese girl, in San Francisco. (She didn't even give me a second look.) To avoid another such experience, here I am. Not having ever been much corrupted by Aristotle, Gibbon, Freud, Marx, or the ACS, I can hope to give a pleasantly objective estimate of the book's virtues and sins.

Now let's look at the book! It contains, in a clearly expressed way, the mathematical analysis of the kinetics of consecutive chemical reactions of the type A = B = C..., and therefore similar to radioactive decay series mother → daughter → grandaughter, etc., except that in chemistry one or more steps may be reversible, or one or more steps may be accompanied by branching of one kind or another, including chain reactions.

On the assumption that all steps in a series are effectively first order, the rate equations consist of a set of n simultaneous linear differential equations of the first order in n dependent variables—the concentrations C_1, C_2, ..., C_n—and one independent variable, the time t. For reactions such as A + Z = B = etc., it is assumed that the concentration of Z is large and doesn't change much. The authors present a considerable number of explicit cases for $n = 2, 3, ...$, and give the solutions of the rate equations in detail as linear functions of exponentials, $\exp(-\lambda t)$, in the time.

The method used by the authors for the solutions of the rate equations is made to depend on Laplace–Carson transforms in which d/dt is replaced by the operator P, which is then treated much like a noncommuting algebraic entity. After some algebra, the final solutions are found to depend on the solution of a simple integral equation. In addition to the treatment of explicit examples in the main body of the book, the authors give, in appendices, a good discussion of the Laplace–Carson method as well as an extensive table of transforms and what they call "originals." The authors helpfully discuss maxima and minima in the concentrations C_i, but are silent about what happens when two or more rate constants are equal.

It is of interest to compare the authors' treatment with the classical one given by H. Bateman (*Proc. Cambridge Phil. Soc.*, **15**, 423 (1910)) in his much cited but apparently little read paper on the radioactivity case (sly dig here at the book by Friedlander and Kennedy). Bateman multiplied all the rate equations by $\exp(-xt)$ and integrated with respect to t from 0 to ∞. In two or three pages he arrives at the solution of the general case including the solution of the simple integral equation.

It seems to this reviewer that the matrix method provides a still simpler means of solving the rate equations (cf. L. Mirsky, "Introduction to Linear Algebra," Oxford University Press, London, 1955, p. 347). Thus if $C = [C_1, C_2, ..., C_n]^T$ is the column concentration vector and $K = [k_{ij}]$ is the $n \times n$ quite general rate constants matrix, then the n rate equations are included in the simple expression $dC/dt = KC$. The solution is clearly $C = (\exp Kt)C_0$ where C_0 is the value of C at $t = 0$, say. For most practical cases, K can be diagonalized with a properly chosen matrix S. In two or three lines it is elementary to show that $C = SDS^{-1}C_0$, where $D = [\delta_{ij} \exp(\lambda_i t)]$. The n numbers $\lambda_1, \lambda_2, ..., \lambda_n$, are the characteristic roots of the K matrix.

So now the chemists have a K matrix to exhibit alongside the physicists' S matrix, which the latter are currently so passionately fond of.

It may now be rightly asked if the book under review contributes anything fundamentally new or useful to science, to chemical engineering or to our over-all culture. Since known principles and rules were used to solve definite problems without uncovering anything truly unexpected, the answer to the first question is probably *no*. Chemical engineers and their hand-

maidens, the organic chemists, may well find the book very useful, which answers the second question. As for culture, the book is not only well written but deserves the serious attention of those distinguished humanists who deplore scientists' efforts to express all manner of things in predictive formulas; sometimes we can. Beauty takes more than one form. For those cornballs who believe that a woman's place is in a doll's house, barefoot, the book shows that we have at least one who can do higher algebra too.

The two equations at the bottom of page 4 don't seem to be correct; the editor of this English edition apparently slipped up there. In the last two pages the authors give their collected references, and here they may be accused of being provincial; if the Russians would only learn to write in Basque, Greek, Spanish, or better still, English, the provincial traits might vanish with the wild winds.

But why split hairs. This reviewer hopes that the Rodiguins collect enough in royalties on their book so that the Señora can have a mink coat and a Rolls-Royce.

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PASADENA, CALIFORNIA

BOOKS RECEIVED

September, 1964

Institute for Scientific Information. "Science Citation Index. An International Interdisciplinary Index to the Literature of Science. Source Index." Institute for Scientific Information, 325 Chestnut St., Philadelphia, Pa. 19106. 1964. 158 pp. $1250 per year, educational organizations; $1950 per year, industrial organizations.

Institute for Scientific Information. "Science Citation Index. An International Interdisciplinary Index to the Literature of Science. Citation Indexes." Institute for Scientific Information, 325 Chestnut St., Philadelphia, Pa. 19106. 1964. 263 pp. $1250 per year, educational organizations; $1950 per year, industrial organizations.

H. H. MITCHELL. "Comparative Nutrition of Man and Domestic Animals." Volume II. Academic Press Inc., 111 Fifth Ave., New York 3, N. Y. 1964. 840 pp. $28.00.