qualify as an essential pre-calculus course; and a post-calculus course covering these topics should be more sophisticated. Except for the section on Boolean algebras, the treatment is more intuitive than axiomatic, although definitions are numerous. I prefer this kind of approach in the elementary courses for which this text is intended, and in no way fault the book for its lack of sophistication.

The book is organized into three independent parts: Part 1, Elementary Theory of Sets (234 pp.); part 2, Introduction to Mathematical Logic (120 pp.); part 3, Abstract Mathematical Systems (93 pp.). A novel feature is that each of these three parts is available separately in paperback form, at a considerable saving, of course, if one is not interested in the entire book. Also, answers to each section are printed at the end of each part rather than being collected at the end of the book. The author gave the answers more attention than most authors do; liberal use of figures and graphs is made in presenting the answers.

The book should receive serious consideration as a text for courses for either prospective elementary or junior high school mathematics teachers, *if* these students are already proficient in the rudiments of arithmetic.

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Space Science

Lunar Missions and Explorations. C. T. Leondes and R. W. Vance, Eds. Wiley, New York, 1964. xx + 669 pp. Illus. $17.50.

Lunar Missions and Explorations is a "textbook" written as an outgrowth of one of the University of California's Engineering and Physical Sciences Extension Courses. It is a textbook by assertion only; it is in fact a compilation of lectures given during the spring of 1963 by 14 lecturers drawn from the aerospace industry and from governmental laboratories. A majority of the lecturers are executives (and recognized authorities), and most have done commendable jobs of discussing their subjects.

These discourses range from a discussion of propulsion principles to generalized studies of vehicles to return man from the moon. Only one, Schurmeier's "Lunar exploration," treats a lunar mission (in this context Webster's *Collegiate Dictionary* defines a mission as a definite task or errand), and none considers exploration of the moon. Most deal with the trajectory and vehicular aspects of the U.S. lunar programs.

As I attempted to plow through Stoner's "Launch vehicle systems" (112 pp.) and Hornby's "Return launch and re-entry vehicles" (76 pp.), I could imagine myself not in a classroom but rather at a technical symposium attempting to assimilate a little from each of the highly technical and detailed slides appearing in endless procession. Indeed the book resembles the proceedings volume of a well-organized symposium more than it resembles a textbook. It is intended for professional engineers, and although a few nonprofessional readers will enjoy portions of the book, particularly the chapters "Lunar environment" and "Lunar exploration," most will find the discussions too technical. The latter chapter, primarily a discussion of photography of the moon by Ranger, is largely historical rather than expository.

The editing of the book was evidently hasty. The orbital period of the earth about the sun is given as 365.5 days (p. 4); the induction of a "gravitational" force by rotation is alleged (p. 92); "descent" is used in place of "ascent" (p. 133); and the numbers are omitted from one figure (p. 501), to cite a few instances of insufficient editing.

In a statement on the dust jacket, the publishers predict that the book will become a source document, but the index contains fewer than one entry for each two pages of text and eight of the 14 chapters have fewer than four references.

I suspect that all astronomers other than those enamored with radio astronomy will skip lightly over Rechtin's comment (p. 426) that listening to radio noise from stars is the essence of modern astronomy. I recommend the book only to those professionally involved in the lunar programs.

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Physicochemistry

The Physicochemical Principles of Igneous Petrology. A. N. Zavaritskii and V. S. Sobolev. Translated from the Russian edition (Moscow, 1961) by J. Kolodny and R. Amoils. Israel Program for Scientific Translations, Jerusalem; Davey, New York, 1964. x + 414 pp. Illus. $14.

Zavaritskii's *Physicochemical Principles of the Petrography of Igneous Rocks*, which was first published in 1926, was one of the first books to recognize the importance of physicochemistry to an understanding of igneous petrology. At the time of his death (about 1955), Zavaritskii was at work on a thorough revision and updating of this book. Sobolev has taken Zavaritskii's notes and brought to completion the revision of Zavaritskii's book.

This book is a good to excellent presentation of the application of thermodynamics and physical chemistry to igneous petrology, and it contains a summary of the many systems that have been studied and are of interest to igneous petrologists.

The first half of the book is devoted largely to the fundamental physicochemical aspects of igneous petrology, with creditable discussion of thermodynamics and of methods of representing equilibria in multicomponent systems and a general review of phase diagrams. Part 2 is devoted to the various well-studied unary, binary, ternary, and quaternary dry systems of importance to igneous petrology. Most of this work is a summary of the various dry systems that have been studied, mainly by Bowen and Schairer at the Geophysical Laboratory. This is followed by a general review of all systems of importance to chemical petrology where one component is a volatile, either carbon dioxide or water.

This book suffers in that it is somewhat dated. Sobolev's revision was probably completed in 1957; there are no citations from the literature published since that time, although a vast amount of data, particularly at very high pressures involving systems where one component is a volatile, have been published. The book has a substantial number of the standard errors that one finds in a volume of this kind. I noted such errors as the statement that alpha

quartz slowly inverts to beta quartz at 573°C. On page 171 the statement is made that granites melt within a range of 1215° to 1260°C, whereas on page 173 the more nearly correct statement is made that dry granites begin to melt at 900° to 950°C. I also noted the standard errors of omission—for example, the statement that calcite at normal pressure undergoes dissociations at 910°C but at 20 bars pressure the temperature of dissociation is 1110°C. The unwary student may not realize that the pressure here involved is actually partial pressure of carbon dioxide and not total confining pressure.

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Microbial-Molecular Biology

Tetrapyrrole Biosynthesis and Its Regulation. June Lascelles. Benjamin, New York, 1964. xii + 132 pp. Illus. $7.70.

This book can be highly recommended, to both students and specialists, as a compact introduction and review of the biosynthetic chain that is concerned with the synthesis of the two major pigments of protoplasm, heme and chlorophyll. The student of biochemistry will find here more detailed and extensive information than that provided by the chapter reviews now available; and the specialist will find a useful review of the porphyrin biosynthetic chain in microorganisms, for the author is a recognized authority in this field. The most novel part of the volume is a review of the recent studies of control mechanisms of heme and chlorophyll biosynthesis, a subject that has been greatly enriched by the author's own contributions.

The book contains five chapters. The first is concerned with the nomenclature and formulas of the various tetrapyrrole pigments, characteristics of their absorption spectra, and general principles of isolation, all briefly summarized with adequate references.

The second chapter summarizes the distribution of heme proteins with especial attention to the heme proteins of the lower organisms. These include the hemoglobins of fungi, protozoa, and legume-root nodules, and the cytochromes of fungi, photosynthetic purple-sulphur bacteria, and the aerobic and anaerobic bacteria. The distribution of the porphyrins of photosynthetic and nonphotosynthetic bacteria, the vitamin B_{12} group, and the chlorophylls is also reviewed.

Chapters 3 and 4 describe the individual steps of biosynthesis from succinate and glycine to heme and chlorophyll.

The control mechanisms are discussed in the last chapter. Evidence for feedback inhibition and repression of heme biosynthesis in *Rhodopseudomonas spheroides* is reviewed. The intriguing effects of the presence or absence of oxygen on the hemoglobin level in vertebrates, and on the formation of various cytochromes in higher and lower organisms, are discussed. Finally, the regulation of heme synthesis in animal tissues is reviewed.

This book is the second of a series of specialty monographs on areas of microbial and molecular biology. The editors are to be congratulated on their excellent choice of an author who knows firsthand the material discussed, and who has lucidly synthesized the story of heme and chlorophyll formation from an intimate knowledge of the biology and biochemistry of both the lower and higher forms of life.

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Low-Energy Nuclear Physics

Introduction to the Atomic Nucleus. J. G. Cunninghame. Elsevier, New York, 1964. xii + 220 pp. Illus. $9.

The author has succeeded admirably in his purpose which is "to present the essentials of the physics of the atomic nucleus in a way which will be intelligible to those scientists who are not nuclear physicists, but who need some knowledge of nuclear physics in their work." The book is concise (210 pages), and Cunninghame's approach is descriptive rather than mathematical. The book is especially concerned with nuclear phenomena at low excitation energies. Physical concepts are emphasized with illustrations that are quite relevant and helpful. Where necessary —for example, in treating the theory of beta decay—mathematical expressions are used, but the reader is not burdened with their justification. The expression itself is used to elucidate the physical situation. An excellent bibliography, which refers to more advanced texts or, in many cases, to the original literature, is given at the end of each chapter.

Because attention is directed to low-energy nuclear physics, where applications are more likely, the nuclear shell model and the liquid drop model are stressed, although the collective models are only briefly mentioned. Direct reactions and the optical model are not treated.

A short but pertinent historical introduction precedes a general description of nuclear properties and forces. Natural and artificial radioactivity are discussed quite adequately, with additional chapters on alpha and beta decay and gamma emission. The major aspects of nuclear fission are well described in the chapter devoted to this subject.

Those who are concerned with applications of nuclear physics should find the concluding chapter quite useful. In that chapter the author discusses the interaction of heavy charged particles, electrons, gamma rays, neutrons, and fission fragments with matter. The salient features of each type of interaction are concisely but accurately presented, and many references are provided for those who wish additional information.

This book should be most welcome to the nonnuclear scientist in that it provides an excellent survey of the principal features of low-energy nuclear physics in a thoroughly readable manner.

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Documents on Modern Physics

Motion of Charged Particles in the Earth's Magnetic Field. Joseph W. Chamberlain. Gordon and Breach, New York, 1964. x + 33 pp. Paper, $1.95; cloth, $3.95.

This booklet, which is published as a part of the Documents on Modern Physics Series, contains one of the series of lectures presented at the Les Houches Summer School of Theoretical Physics (1962), and published in