genation. This phase of hydrogenation has not been reported in detail, but recent articles show, in some cases, a dramatic effect, particularly on the rate of reaction, if excellent agitation is provided.

Although it is stated that it is beyond the scope of this book to discuss the mechanism and kinetics of hydrogenation reactions, I would have welcomed a short section with references on this phase. Also, I would have appreciated a short discussion on hydrogenations that may be carried out in the vapor phase.

The references are excellent and well selected for the purpose intended. However, there is additional excellent information in the patent literature, and this source of information is almost totally neglected.

In spite of the minor shortcomings noted in this review, I believe that this book is a "must" for anyone interested in hydrogenations and that it will be well received by both academic and industrial research groups.

C. H. McKEEVER
Rohm and Haas Company, Philadelphia, Pennsylvania

Mathematics for Engineers

John Cunningham's **Complex Variable Methods in Science and Technology** (Van Nostrand, Princeton, N.J., 1965. 186 pp., $7.50), as one can see from its title, is intended as a textbook on elementary complex variable methods for students of engineering. The first two chapters contain a short review of such topics as partial differentiation, multiple integrals, and De Moivre's theorem from calculus. The next four explain the more important elementary topics in analytic function theory—for example, analyticity, the log function, Cauchy's theorem, theory of residues, and improper integrals. The last two chapters treat the beta, gamma, and delta functions and differential equations.

The first two chapters are rather brief, considering the number of topics covered. The middle four adequately explain the meaning of theorems and illustrate the technique of applying the theorems. In the last two chapters several different topics are treated in a rather brief space. For instance, these chapters contain the solutions of several differential equations in terms of contour integrals. The level of difficulty of the first part of the book indicates that it is intended for an engineering student who has just finished calculus, but such a student will not have the mathematical background and maturity to fully grasp the more difficult material in the last two chapters without considerable help. Although the book contains few proofs of theorems, the meaning of theorems is amply illustrated by example. Most of the explanation of theory and technique is by example. The wealth of challenging exercises at the end of each chapter is one of the best features of the book.

The author has made some mistakes in judgment—on page 124 he defines $z^a = 0$ for $z = 0$ and $\alpha \neq 0$ instead of $z^a = 0$ for $z = 0$ and $\mathrm{Re}(\alpha) > 0$; on the top of page 88 the last expression should be $\lambda\epsilon\ (z - z_1)^{-1}$ instead of ϵ. Here λ denotes the length of the curve joining z and z_1. The author could have been a bit more careful in his statement of theorems and definitions. For example, it is not clear on what kind of sets he defines analytic functions. On page 23 he uses the expression "curve with no double points" and on page 76 "simple closed curve." The meaning in the second case certainly requires an explanation, but none is given. Sometimes the author does not give an adequate introduction to ideas before using them.

It is not clear that such shortcomings should be given any consideration in reviewing a book of this kind, for this is a somewhat modern version of an old-fashioned "how to" textbook of mathematics for engineers. *Complex Variable Methods in Science and Technology* is unique in that at this level it is the only one of its kind. Hence, it will serve a purpose. It is well written and easy to read.

CHESTER MIRACLE
Department of Mathematics, University of Minnesota, Minneapolis

Lunar Atlas

Photographic Atlas of the Moon (Academic Press, New York, 1965. 277 pp., $16), by Zdeněk Kopal, Josef Klepešta, and Thomas W. Rackham, with a foreword by George H. Chase and a preface by Jean Rösch, presents a handy view of what was known, up to the end of 1964, both from photography and from measurement, about the moon. The lack of an index and of an index map for the plates are serious inconveniences.

The core of the book is a series of 197 plates of the moon, beautifully reproduced from photographs taken at the Pic du Midi Observatory, in the Pyrenees, with a 24-inch reflector. These photographs do not have quite as much detail as those in Kuiper's much larger atlas; and both atlases fall far short of the (unfortunately very few) Herbig photographs from Lick. In Archimedes, for instance, the present work shows two craters; Kuiper's atlas shows five, and Herbig shows 27; in Ptolemaeus, Kopal shows 17, Herbig 70. A few plates, particularly No. 178, are as good as anything in the field. Kopal's book is, however, 10 by 13½ inches and thus is small enough to keep on a desk; the Kuiper atlas is not, and the Herbig photographs cover only a small portion of the lunar surface.

The bulk of the atlas consists of 19 of the terminator photographs, each printed as a set of seven plates. Each set of seven is arranged in order from south to north along the terminator. The approximate coordinates of each plate are printed alongside, so that it is possible to identify the detail on the plate with that on a gridded map in a pocket at the back, though the procedure is unfamiliar.

In addition, there are 20 plates of the whole disk throughout the month, 45 plates of regions of especial interest, and 9 prints from Ranger VII.

The bulk of the text is a 60-page dissertation on the moon, by Kopal. The first section treats the moon as a whole: mass, radius, density, and problems of thermal evolution. The second section concerns the craters; both impact and caldera theories are carefully discussed. Shoemaker's studies in lunar stratigraphy are summarized. The third section gives a lucid account of the nature of the lunar surface as deduced from photometric, radio, radar, and thermal data and other evidence. A 13-page chapter by Kopal and Rackham on the photography of the moon concludes with a discussion of the production of the atlas.

Kopal's style is vigorous, readable, and inclined to paradox. There is no bibliography.

At its price, $16, the atlas will be valuable as a basic tool to many who cannot afford Kuiper's atlas; for all workers, it will be valuable because of its compactness. It may serve as a stimulating introduction to the problems of selenology for readers with a general scientific education.

JOHN A. O'KEEFE
Goddard Space Flight Center, Greenbelt, Maryland

Plasma Physics

Those who choose their books from a catalog should take care not to confuse this book, **Elementary Plasma Physics** [Blaisdell (Ginn), New York, 1965. 198 pp., $2.25], by Lev A. Arzimovich, with another of the same title, *Elementary Plasma Physics* by C. L. Longmire. The latter is really an introduction to the mathematical theory of plasma physics, first rate but quite hard.

So, Arzimovich's *Elementary Plasma Physics* is truly an elementary text, put together with signs of much forethought, by a definite authority in the field and, let me add, by quite a personality (glints of this personality can be seen here and there in these pages, even in translation).

Arzimovich defines the electron volt unit of temperature commonly used in plasma physics, but unfortunately uses it but little in the text. It is true that astronomers seem to manage very well in talking of millions of degrees, but I find 9 kev temperature much more informative (type of radiation, energy levels of excited state involved, and so forth) than 102 million degrees.

In the chapter where he introduces the Maxwell distribution, I would like the concept of 1/2 kT per degree of freedom brought out more than that of mean energy, but this is perhaps a matter of taste.

The important but difficult topic "Plasma in a magnetic field," chapter 7, is treated with great didactic skill.

Controlled fusion is apparently Arzimovich's main activity these days; he is the author of a book on that subject. He directs the Plasma Physics Division of the Kurchatov Institute in Moscow and is believed to wield some authority over the whole of the highly regarded U.S.S.R. controlled fusion project which absorbs a substantial fraction of the best physics talent in Russia. I like their work very much. So when he gets around to chapter 8, "Controlled fusion," one prepares for a feast. Alas!

What is it about controlled fusion research that causes perfectly respectable physicists to take leave of their senses? Perhaps Plato was right when he said that "only matters without utility are proper objects for contemplation by a philosopher." I always thought, myself, that this was a most mischievous remark. But there it is. We see that practitioners of controlled fusion research build great expensive machines, which, so far as approximation to thermonuclear reactors is concerned, would make better refrigerators. I too, in spite of the monumental difficulties, am quite confident that a thermonuclear power producing reaction is not far off: however, I doubt that it will take place in anything resembling those big machines.

After seven chapters on plasma physics handled with impeccable scholarliness, what would one expect to learn about controlled fusion? Since the aim of controlled fusion is to achieve a net output of energy, one must discuss the energy balance of thermonuclear reaction yield versus plasma losses, by bremsstrahlung, diffusion, magnetic radiation, and magnetic bottle maintenance. Is this done? Never mentioned. The above considerations lead to a vital criterion for power production in a thermonuclear reaction—that temperature being high enough, there exists a minimum value of density $\times$ time ($n\tau$). Never mentioned. The ability to trade off density for time which this criterion confers, leads to various important conclusions about thermonuclear reactors. Never discussed. The hopes for a positive power balance from a thermonuclear reaction hang on the fact that the fuels are hydrogen isotopes which radiate very little. Never mentioned.

So much for what he omits: Now, what does he say? He says: "This means that 1/10 second represents a satsfactory retention of particle in the plasma. This result was achieved by M. S. Ioffe in the Department of Plasma Studies of the Institute of Atomic Energy of the USSR and is the major achievement in the development of controlled thermonuclear reactions in recent years."

Do we hear the horns of propagandaland faintly blowing? Well, perhaps a bit, but never mind: Everybody has admired Ioffe's achievement, and it has been widely copied. It is a triumph of principle but not a confinement duration record.

For if you want to boast of Ioffe's achievement in terms of confinement time τ (which I believe to be irrelevant), it is greatly exceeded in that respect by the Oak Ridge DCX experiment (70 seconds). If you want to rate it in more meaningful terms $n\tau$, it is exceeded greatly by the Los Alamos Scylla θ-pinch plasma. So he boasts for the wrong reasons.

He goes on to say ". . . a number of premature reports that this has been achieved, in reality nobody has succeeded in maintaining pure hydrogen plasma at high ion temperature in a magnetic trap for more than a few tenths of a microsecond." Simply not true. The Scylla plasma maintains 4×10^{16} ion/cm^3 (a very high density) at ion temperature of > 5 kev (a very high temperature) for three microseconds at a purity level which radiates bremsstrahlung at $2 \times$ theory (a very high degree of purity). But there we go again. My own Sherwood syndrome is perhaps speaking.

In conclusion: To teach the fundamentals of plasma physics to readers with a high school education—the book is excellent and recommended. However, for information on the application of plasma physics to controlled fusion—the book is partisan and inaccurate.

JAMES L. TUCK
Los Alamos Scientific Laboratory, Los Alamos, New Mexico

Geochronology

The art and science of nuclear age determination on rocks has been summarized and reviewed in a few chapters of books on broader subjects during the past decade or so, and the three or four books and booklets on geochronology have been published in the Soviet Union. We have here the first full-length book on the subject written in English.

Applied Geochronology (Academic Press, New York, 1965. 283 pp., $10), by E. I. Hamilton, with a chapter on comparative geochemistry by L. H. Ahrens, is a book crammed with information on theory, technique, and interpretation of all kinds of nuclear age meas-