terests in reaction rates and ionization processes. The coverage of areas outside of their interests is sparse. The value of the book lies mainly in the treatment of radiations, ionizing processes, and closely related subjects. On peripheral topics, such as atmospheric motions, the treatment tends to be less penetrating. The typography, illustrations and style of writing are clear, and the monograph will be a useful introduction and reference work in the field.

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Computability Theory

The present book, **Enumerability, Decidability, and Computability** (Academic Press, New York; Springer, Berlin, 1965. 255 pp., $9.75) is a translation by G. T. Herman and O. Plassmann of a work by Hans Hermes which was originally published in German in 1961. Hermes is well known for the lucidity of his exposition, and as one would expect, his book is a masterly introduction to the subject. It does not go far into the remoter reaches of its field, but what it does it does with great clarity and thoroughness. A beginning student will find most developments well motivated, and many points that the original papers tend to take for granted are explained in detail; the expert will find it useful for recalling details concerning fundamental theorems.

The book begins with a general discussion of algorithms and formal methods. The next three chapters deal with μ-recursiveness—that is, with functions generated in standard fashion by the primitive recursive operations and the μ-operation—and general recursive functions as defined by systems of equations. The fundamental theorems for these kinds of functions, due mostly to Kleene, are proved, including the equivalence of each type of computability with the preceding type. However, only everywhere-defined functions are treated; partial recursive functions are barely mentioned. There follows a chapter on the application of these results to the undecidability theorems which have become more or less standard. The final chapter treats a number of supplementary topics, including the universal Turing machine, the basic properties of enumerable and arithmetical predicates, brief sketches of alternate formulations of computability, and recursive analysis.

The chapter on general recursiveness is capable of improvement in one respect. There are some advantages to stating the rule of replacement without involving substitution (thus emphasizing that it deals only with constants), and allowing only one occurrence, and that on the right, to be replaced. This gives the evaluation of a function an algorithmic character. The equation scheme given for $\mu y(g(x, y) = 0)$, on page 126, seems clumsy, and in any event could not give an algorithm in the sense just explained, because two different equation schemes have the same left side. It is possible, however, to satisfy that requirement as well as those stated in the book; this is done by the following equation schemes, where h can be, for example, the h^* of the book (or g if one is not concerned about having Φ a total function), and δ, Φ are new auxiliary functions:

$$\delta(x,y,0) = x, \qquad \delta(x,y,z') = y,$$
$$\Phi(x,y) = \delta(y,\Phi(x,y'), h(x,y)),$$
$$f(x) = \Phi(x,0)$$

The translation has been very well done. However, there are a few Germanisms that might bother a reader who knows no German. One example is the translation of the German word "Paragraph" as "paragraph," whereas the German term, as used by Hermes, indicates a much larger section of the text than what we customarily call a paragraph. There are other such cases, and a number of misprints, but these should not bother a reasonably alert reader.

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Organic Synthesis

The author, Robert L. Augustine, states that his book, **"Catalytic Hydrogenation** [Dekker, New York, 1965. 200 pp., $8.75] is designed as a guide for those interested in using hydrogenation as a synthetic tool." For this purpose it is excellent.

The book presents (i) discussion of different types of apparatus available in many organic chemistry laboratories and provides operating instructions for this equipment; (ii) discussion of catalysts, the effect of variables such as temperature and pressure on the outcome of a hydrogenation, the choice of catalyst for the specific hydrogenation to be carried out, and the preparation of the common catalysts and (iii) recommended procedures for the hydrogenation and hydrogenolysis of functional groups. Although many references are included at the end of each chapter, this book is designed to provide sufficient information so that in most cases it will not be necessary to consult and study these articles before carrying out the hydrogenation experiment. I believe that the author has accomplished his objective.

Chapter 2, on apparatus and techniques, is limited, and the section on high pressure equipment somewhat out of date. Several equipment manufacturers have available stirred autoclaves which may be operated up to 7000 to 8000 pounds per square inch and which have better agitation and heat control than the rocker-type high pressure unit. Neither of the units described has any provisions for cooling. Because almost all hydrogenations are exothermic, in the apparatus described it is often necessary to carry out the reactions at the lowest possible temperature range in which the reaction can be obtained in order to control the temperature. In selective hydrogenations, I have found that this is neither convenient nor desirable. In addition, lengthening the hydrogenation time from minutes to hours may cause undesirable side reactions, particularly that of the hydrogenation product with the reactant.

As is customary in academic articles, safety is treated lightly and inadequately. Instead of merely mentioning that "some hydrogenations are highly exothermic," it would have been preferable to point out, in the safety section and in the detailed section on hydrogenation of functional groups, the places where special precautions should be taken. For instance, it should have been emphasized that catalytic hydrogenation of nitro groups must be carried out in a unit provided with cooling and at as low a pressure and temperature as possible, or a runaway reaction will probably occur. Other systems such as those in which telomerization as well as hydrogenation may occur also require special precautions.

In the discussion of catalyst and conditions (chapter 3), there is no mention of the effect of agitation on either rate or selectivity of the hydro-

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.

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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.

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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