ample, function spaces in chapter 5 and homotopy and isotopy properties in chapter 2). This book is written for mathematically mature students, knowledgable about basic logic, relations, cardinality, and the like. Quite abstract, it is intentionally shy on examples and illustrations. The student and the instructor must be prepared to provide these along with motivational discussion. The author justifiably prides himself on complete and clean-cut definitions and proofs of everything presented (for example, in chapter 6, "Fundamental groups," the group of a circle is rigorously determined, an uncommon feat in an elementary text).

In my opinion, the intelligibility striven for might be enhanced by leaving out some of the more repetitive details in simpler cases in favor of additional discussion or illustration in more difficult cases. The treatment of product maps could be improved by use of commutative diagrams, and definitions of continuity, exterior, interior, and boundary points simplified by making fuller use of the author's choice of definition of neighborhood. Amazingly, there appear to be practically no errors in the text, except printing errors which are largely confined to some careless typography in the first 25 pages and incorrect cross-references here and there. Interesting and valuable exercises of varying difficulty are abundant. Anyone who absorbs a major portion of the material presented will have an excellent grasp of basic topology.

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Electro-optical Sciences

Principles of Optics. Electromagnetic theory of propagation, interference, and diffraction of light. Max Born and Emil Wolf. Pergamon, London; Macmillan, New York, ed. 2, 1964. xxviii + 808 pp. Illus. $17.50.

A new optics is being born in the world of science, and, with the possible exception of its impact on technology, it probably has been largely unrecognized. During the last decade or two many of the most dramatic advances made in the field of optics were directly stimulated by, or originated in, advances in electrical engineering, in its various branches of communication sciences, microwave electronics, and radio astronomy. The operational Fourier-transform treatment of optical image forming processes and of spectroscopy, the introduction of resonant structures and of optical feedback control, the remarkable simplicity of optical computing, communication systems and coherent-background (heterodyne) detection, the exploitation of the statistical and coherence properties of electromagnetic signals and radiations as well as polarization in interferometry and astronomy, the dramatic development of light amplification and control in optical masers and, more recently, the newly dramatic achievements in "lensless" photography and "automatic" character recognition, and nonlinear optics—these are some of the better known examples of the interdependence of theory and techniques throughout broad ranges of the electromagnetic domain: in astronomy, radio astronomy, physics, and electrical engineering. Skillful recognition and exploitation of basic similarities in pursuits throughout the entire electromagnetic domain are proving most fruitful in pinpointing new areas of research and of industrial applications in what may well be called the new field of "electro-optical science and engineering."

Perhaps the single most important element in the rapid development of the electro-optical sciences is the great experimental simplicity resulting from the deliberate use of sophisticated mathematical formulation. To paraphrase C. H. Townes (in *The Age of Electronics*, 1962, edited by C. F. J. Overhage), one may say that the recent dramatic developments in electro-optical science, including the maser, "epitomize the great change that has recently come" over the optics, optical computers, interferometric gratings, lensless photography, optical filters, and automatic "reading" systems, to mention only a few. These developments, which were predicted and worked out "almost entirely on the basis of theoretical ideas of a rather complex and abstract nature," are not inventions or developments "which could grow out of a basement workshop, or solely from the Edisonian approach of intuitive trial and error." They are rather creatures of our present scientific age which have come almost entirely from modern theory in physics, communication sciences, and indeed in electro-optical engineering.

There is no single text which deals with all of these developments, or even with the "principles" involved. Born and Wolf's *Principles of Optics* was not written to even attempt to do this. In fact, there is hardly a text that on its own could serve as a point of departure for this vast new activity, which has recently attained a $1 billion mark in the United States alone.

However, the reader who is looking for a masterful treatment of many of the *fundamentals* in *classical* optics, which are no doubt the basis of many of the sophisticated developments that are now at the focus of interest, is not likely to find a book that provides a more rigorous and exhaustive treatment. Another invaluable aspect of the book is the wealth of beautiful mathematical treatments accorded many aspects of optics: diffraction theory, optics of metals and of crystals, and several other subjects such as diffraction of light by ultrasonic waves, interference, and diffraction with partially coherent light. In the 14 chapters and 9 mathematical appendices, there are contributions by A. B. Bhatia, P. C. Clemmow, D. Gabor, A. R. Stokes, A. M. Taylor, P. A. Wayman, and W. L. Wilcock.

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On Encyclopedias

The Columbia Encyclopedia. William Bridgewater and Seymour Kurtz, Eds. Columbia University Press, New York, ed. 3, 1963. xii + 2388 pp. Illus. $49.50.

The Columbia Encyclopedia, which has been in existence for 30 years, is one of our standard reference sources for ready information about a diverse number of subjects. It is especially useful for such information as dates and the principal works of people, names in the Bible, and miscellaneous geographical statistics. Scientists who desire to look up such things as Buddhism, manichaeism, free silver, the names and dates of Canadian prime ministers, minor literary figures, or the population of some inconsequential town will find this a useful reference.

This is the third edition, and some 200 pages have been added. According to the implication on the dust jacket, this revision has taken cognizance of advances in science, although admittedly the articles are for the general reader and not, as stated for example, the nuclear physicist who certainly knows more about his own field than an article in such a work as this can possibly tell him. Fair enough; what then of the nuclear physicist who may consult this volume with respect to matters outside his field—for example, material published in *Science?*

He will find rather good coverage on all sorts of plants, usually to family name and specific identity. Evidently someone with some knowledge of botany supervised these entries. However, he will not find an entry for *Neurospora* or for mould, although there is an excellent entry for penicillin. The editors have not caught up with gibberelin or gibberelic acid. Zoological entries are on the whole much less satisfactory than botanical ones; seldom is the name given for the family or the species of an animal (except for such familiars as cat, dog, and horse), and often there are errors. Prawns do not differ from shrimps in the possession of a rostrum; the bluefin tuna is not "also called the horse or jack mackerel"; barnacles are not classified among the "larger crustaceans," and the crab illustrated on page 1039 is not *Callinectes sapidus.*

Zoological information seems to have been downgraded to a certain extent in this edition. Under skunk, for example, generic names have been omitted (although the matter of omitting formal family names in zoology but including them in botany is a trait of both the second and the third edition), whereas skunk cabbage, which is cross referenced to arum, yields names of major species of Araceae. In short, this encyclopedia will irritate a zoologist, but it will probably be acceptable to a botanist. The entries under evolution and genetics (sans *Neurospora!*) are well done.

The plates, which were gathered together at the end of the second edition, are scattered through this edition so that they could be placed near the appropriate entries. By virtue of this reshuffling, ecology has become a major entry because two pages of illustrations formerly labeled "Animals, terrestrial life zones" are now labeled "Ecology"; the short article that appears under this name, however, will not please most ecologists.

The chief utility of an encyclopedia such as this is to supply just enough information to meet casual curiosity and immediate need for clarification or amplification, and beyond that to guide the reader to further information. In the first uses this work serves well for the scientist seeking such information outside his field. Some of the references, however, seem oddly chosen, and quite often reference is made to the "study by Doe, 1954" without further explanation. Such references may be difficult to locate and accurately identify.

In summary, although *The Columbia Encyclopedia* can be recommended to scientists for general nonscientific matters, it sometimes falls short for clergymen and politicians (one wonders if a physicist would be satisfied with the entry for laser) who may be reading a copy of *Science.* It is not very enlightening, for example, to be informed that the contributions of Josiah Willard Gibbs "have had a profound effect on industry, notably in the production of ammonia." Nevertheless, the general usefulness of this encyclopedia greatly offsets its comparatively minor shortcomings, which will perhaps be taken care of in subsequent editions. Encyclopedia editors obviously have as much difficulty keeping up with science as the rest of us, and on the whole this encyclopedia's editors have done well.

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Surface Science

Recent Progress in Surface Science. vol. 1. J. F. Danielli, K. A. G. Pankhurst, and A. C. Riddiford. Academic Press, New York, 1964. xii + 414 pp. Illus. $16.

This is one of the many recently published collective volumes, perhaps even a typical one, for it has three noncontributing editors and 14 authors who have contributed 11 chapters (four authors are responsible for the shortest of the chapters). The need for collective effort in an authoritative presentation is made obvious by considering the scope of this volume, which ranges from the theory of the double layer (Haydon) to the description of cell contacts in tissues as studied by electron microscopy (Mercer), and from the behavior of soap films (Kitchener) to the surface of semiconductors (Tannenbaum-Handelman), and includes, among others, chapters on surface viscosity (Jolly), electrode processes (Schuldinger), and facilitated diffusion (Stein). Perhaps a collective book review is also indicated, because any single reviewer is likely to be introduced to some new subjects while he is preparing his "critical judgement."

It is certainly true that our information explosion has aggravated the fragmentation of this information so that, as is well stated in the preface, work of importance to one or more branches of surface science "is locked up in journals designed to cater for the specific needs of another branch. Coupled with this is the tendency for workers in a branch to use their own terms for concepts which are, or may become, common. . . ." Thus, there is a real need for collective volumes "of critical reviews of the different disciplines," through which specialists working in one area can try to communicate with those working in different areas. Such reviews must be very different, however, from reviews and especially from research reports designed for fellow specialists in the same discipline. It would seem to be the responsibility of the editors to insist that, at least in this respect, a collective volume must be reasonably homogeneous, with clear definitions of any little known concepts, in order to accomplish its stated purpose. In volume 1 of *Recent Progress in Surface Science* some articles do accomplish their purpose splendidly. Those on semiconductors, corrosion, and facilitated diffusion are particularly informative. The one on foams and films should also be very illuminating for many readers although, as a "fellow specialist," I could argue some minor points. Some of the other chapters tend to deviate to lesser or greater extent from this objective, but they often compensate for their deviation by the completeness of their treatment and the richness of their references. A minor but irritating example of the type of deviation to which I refer is the repeated use (in chapter 10) of "PAS positive" without any explanation of its meaning.

The unique scope of this book, and