Books

High Speed Photography. By George A. Jones. 311 pp. John Wiley and Sons, Inc., New York, 1952. $6.50.

Except among the small and select group who practice the craft, engineers and scientists seldom appreciate the extent to which high speed photography has grown to be an essential tool in almost every branch of scientific research and development. A bird's-eye view of the techniques and applications of this means for recording events which occur too fast to be seen is furnished by George A. Jones in *High Speed Photography*. Of course, the line of demarcation between ordinary or slow speed photography and high speed photography is poorly defined. For the purpose of this book, the author has accepted a suggestion of the Society of Motion Picture and Television Engineers that this line be established at exposure times of less than one millisecond or at picture frequencies of more than 250 per second. This recommendation rules out both ordinary flash or sports photography and slow motion cinematography.

Most of the practice of high speed photography has been covered in articles in the technical journals, while general texts on the subject are practically nonexistent. Under this condition, an author is tempted to cover the whole field in one book. Jones could not resist this temptation. And in consequence, he has prepared a compendium of the technical papers on the subject during the century dating from Fox Talbot's suggestion for spark illumination for photography in 1851. Unfortunately, to weld such a mass of source material into a readable whole requires writing skill of a high order. It probably is charitable to suggest that this book may become a handy source book, and that it is most valuable for the rather complete bibliographic references included in each chapter.

In the preface to *High Speed Photography*, dated March 17, 1951, Jones states: "Apart from Edgerton's 'Flash!'—a fascinating introduction to the work of a pioneer, but restricted to a portion of the whole field—no modern book existed on the subject or on any allied topic." An unfortunate statement, explainable only on the basis that Chesterman's * excellent monograph on the subject of high speed photography may have been in the publisher's hands at the time Jones was writing it.

One is tempted to compare these two books. In this reviewer's opinion, Chesterman has exercised fine discrimination in selecting the material which he treats, with the result that he has produced an excellent text on the subject. On the other hand, Jones seems to have given equal weight to every technique he found described in the literature, with the result that the uninitiate would be hard put to choose the method most suitable for his specific problem. One expects Chesterman will be studied by the novice and Jones will be cited by the historian.

W. T. Wintringham
Bell Telephone Laboratories

* W. Deryck Chesterman, *The Photographic Study of Rapid Events*, Oxford, Clarendon Press, 1951.

Introduction to the Foundations of Mathematics. By Raymond L. Wilder. 305 pp. John Wiley and Sons, Inc., New York, 1952. $5.75.

Although intended primarily as a text for a university course at the senior or first-year graduate level, this book, it seems to the reviewer, can be expected to have strong appeal to qualified readers generally. It discusses the foundations (and to some extent the character) of mathematics in a quite thorough fashion but in a sufficiently readable style to be accessible, for example, to theoretical physicists. There is a rather long collection of problems at the end of each chapter to supplement the discussion and proofs in the text. Motivation for and historical development of each subject are given briefly; this helps to keep the interest of readers who are tired of the current desiccated style of mathematical writing.

The first two chapters describe the axiomatic method as it is commonly used in modern mathematics; notions such as consistency, independence and categoricalness are explained, and examples of axiom systems are given. Chapters 3, 4, and 5 are devoted to set theory; its foundations, infinite sets and cardinal numbers, ordered sets and ordinal numbers. Chapters 6 and 7 treat the real number system and group theory, using set theory and the axiomatic method.

Part II of the book, consisting of the last five chapters, is called "Development of Various Viewpoints on Foundations." Discussed are: the early developments, through Zermelo's set theory; the Frege-Russel-Whitehead approach, regarding mathematics as an extension of logic; the intuitionism of Brower and Heyting; the formalism of Hilbert and Bernays (Gödel's incompleteness theorem and decision procedures are discussed in this chapter); and the cultural setting of mathematics.

The reviewer found the last chapter very revealing. It shows how strongly the concepts of mathematical validity, mathematical usefulness, and even of the substance of mathematics itself depend on the prevailing cultural and psychological setting.

The reviewer cannot resist the temptation to remark that mathematics seems to be very far ahead of physics in this matter of examining its own foundations. In comparison with what the mathematicians have done, the scattered works on the foundations of physics seem rather vague and inconclusive. A few brilliant exceptions to this rule, such as Caratheodory's work on thermodynamics, serve to emphasize, by contrast, how profound the lack is in most fields of physics, especially contemporary physics. Theoretical physics long

ago ceased to be merely a concise procedure for cataloguing the results of observation and experiment, and the logical character of the concepts introduced is based, to an extent probably not generally appreciated, on arbitrary conventions. Probably a proper discussion of the semantics of theoretical physics cannot proceed in vague physical or philosophical terms, but will require careful definition of an underlying symbolism and terminology similar to that that has been adopted in the foundations of mathematics.

Robert D. Richtmyer
Los Alamos Scientific Laboratory

An Introduction to Scientific Research. By E. Bright Wilson, Jr. 375 pp. McGraw-Hill Book Co., Inc., New York, 1952. $6.00.

Professor Wilson has written a thoughtful book, useful both as a text for graduate students and others beginning research and as a reference for more mature and experienced researchers who wish to think over what they are doing. In fact, the words "to think over"—as applied not only to the detailed parts but to the whole pattern of a piece of research—characterize the book. If to learn from the experience of others is a mark of exceptional intelligence the researcher is here presented with a golden opportunity for intellectual gain.

The chapters are arranged more or less in the order in which the topics arise in the course of an experimental investigation, from choosing the problem to reporting the results. About half of the text should appeal directly to the common sense of the good graduate student starting research. The other half, mainly devoted to statistical design, analysis, and deduction, may be classed as uncommon sense and will require careful study and reading of references by many who are otherwise well prepared for research in their chosen fields but who have not previously concentrated on statistical matters. The exposition is clear and the author justifies his predilection for statistics by good illustrations and apt anecdotes.

Chapter 1 on "The Choice and Statement of a Research Problem" points out that many scientists owe their greatness to their wisdom in choosing problems and discusses some of the factors besides interest that should be considered both in taking on *and in abandoning* a problem. The importance of carefully stating, defining, and delimiting the problem as well as the need for maximum understanding of the subject and purpose by all concerned are stressed.

Chapter 2 on "Searching the Literature" begins with the sentence "Six hours in the library may save six months in the laboratory." A valuable check-list is given of the principal reference works, literature guides, handbooks, book lists, review journals, and abstracting journals in various scientific fields. Methods of keeping and indexing literature notes are discussed.

The third chapter, "Elementary Scientific Method", reviews the basic ideas of scientific method which are involved in practically every investigation: observation and description, cause and effect, analysis and synthesis, hypothesis, and deduction. Despite the fact that the Introduction disclaims any attempt to deal with the scientific method from the usual philosophical viewpoint and emphasizes that scientific work cannot be reduced to a routine process, philosophers should find much of interest in this book's workaday collection of principles, maxims, procedures, and techniques for the conduct of scientific research. One of Wilson's illustrious colleagues is supposed to have brushed aside all cookbook recipes for "the scientific method" by saying that it consists of nothing more than "doing one's damnedest with one's mind, no holds barred." Actually the present book is more an elaboration than a contradiction of this theme and its author would certainly be among the last to advocate research by rote!

"The Design of Experiments", Chapter 4, invites thought concerning the planning of an experiment to make sure that it is based on clear objectives, to guard against psychological bias and erroneous conclusions ("It has been conclusively demonstrated by hundreds of experiments that the beating of tom-toms will restore the sun after an eclipse."), and to obtain the maximum in pertinent results for the time, cost, and effort expended. In the latter connection the ideas of factorial design, replication, randomization, and levels of significance are introduced.

A wealth of material on "The Design of Apparatus" is outlined in Chapter 5. In these days of supported research it sometimes seems that two admonitions are insufficiently heeded: to devote design care and thought in proportion to the shop time and expense required to execute the design, and, whenever possible, to consult with the mechanician who will do the work during the design stage. Among the design items discussed are accessibility, operating convenience, null measurements, calibration, automatic recording, amplification, impedance matching, feedback and servo systems, and noise as a limitation on all measurements. Thus, the stability diagram for a feedback system is briefly explained, the expression for the mean-square displacement in generalized noise is given, and the formula for thermal noise from a resistor is neatly derived. The "almost universal unwillingness of electronics 'experts' to accept a design which has performed successfully for others" is deplored. A list of references useful to the designer of apparatus is appended.

Strong emphasis is put on keeping written records in Chapter 6, "The Execution of Experiments". This emphasis applies not only to the explicit suggestions concerning the laboratory notebook and the recording of primary data ("An experimental scientist without his notebook is off duty."), but also to plans, circuits, operating instructions, and systematic procedures in bringing an apparatus under control and in trouble shooting. A novel feature here is the listing of fourteen general "search principles" which should be useful in finding gremlins and in overcoming what some experimentalists used to call the Principle of Maximum Vexation or the Fourth Law of Thermodynamics, namely: If anything