was done will have learned a valuable lesson. If he works (as the reviewer did not) the numerous problems carefully integrated with the text, he can scarcely escape this understanding.

The foundation of the subject is in the first four chapters of the book. In the fifth, entitled "Similitude", the dimensionless ratios are brought in, and they are applied to important flow problems involving friction, lift, and drag. Flows of a perfect fluid are discussed in the sixth chapter, and those of real fluids in the seventh, in which the theory of boundary layers is introduced. The last three chapters deal with practical matters, mainly flow in open channels and various aspects of turbomachines.

The preface points out that fluid mechanics has changed from a specialized subject to a fundamental discipline common to several branches of science and of engineering. That this change is part of a broader movement is shown, for example, by the growing recognition of the importance of transport processes in electrochemistry. A page early in the book might have been allocated to showing how transport processes in fluid dynamics fit into the broader framework that includes transport processes of all kinds, even though other indications of this broader relationship are given (e.g., p. 6, second paragraph; pp. 55, 56, and 57; and p. 79).

This is an excellent, clearly written textbook aimed at the junior level.

Modern Developments in Electron Microscopy. By Benjamin M. Siegel, ed. 432 pp. Academic, New York, 1964. $13.50. **Fundamentals of Transmission Electron Microscopy.** By Robert D. Heidenreich, 414 pp. Interscience, New York, 1964. $14.50.

Reviewed by L. Marton, National Bureau of Standards.

It has often been said that the lead time between discovery and its practical application is shortening, to the extent that some time from now, the practical application may precede the discovery itself. I would like to establish here a similar principle applicable to a good part of the modern scientific literature. Instead of lead time we may call it something like the "active time" of any branch of science, which, according to many publications, is being shortened tremendously. What I am referring to is that many modern publications ignore completely what they may consider ancient history, but what I consider the logical antecedents of the part of the science they are reporting. The usual argument in favor of omitting all kinds of historical detail in the presentation of any scientific field is that, "We do not have time to go into ancient history, and anyhow most of it is obsolete." I would like to suggest that one day a PhD thesis in the history of science be devoted to the subject of how much time is wasted by the average researcher due to lack of knowledge of the literature of his own subject, in particular, of the antecedents of his own subject.

Having made these comments, let us proceed to a discussion of the book edited by Siegel.

As you may have guessed, the present "critical evaluation of a wide cross section of current development in electron microscopy" applies the principle of the almost zero "active time" and compresses electron microscopy into the last ten or twelve years of its existence. It would be all right if it were really a critical evaluation of current developments only, but the first chapter (on the physics of the electron microscope), written by the editor himself, presents the general principle of electron optics and of image formation and contrast. I tried to find out for whom this contribution was really written, and the preface states, "The present volume is directed primarily to the research worker who has only recently started to apply the electron microscope in his research. Each contribution has been written so that it will be understandable to research workers outside the particular discipline. The technical vocabulary of the specific fields could not be avoided entirely, but none is so intricate that reading a given contribution would be impossible or without profit." As the book contains eight chapters written by eight authors and only two of the chapters are on physics, I will limit my comments to the two physical chapters; that is, Chapter 1 on "The Physics of the Electron Microscope" by B. M. Siegel and Chapter 5, "Applications of the Electron Microscope in Physics" by D. W. Pashley. Chapter 1 starts with reference to Hamilton's work. Here I would like to inject a remark on a very minor item: Hamilton's middle name is misspelled (on page one, it is given as "William Korvan Hamilton", in the reference list it is given as "Hamilton, W. K., in Mathematical papers of Sir William Rowen Hamilton").

I feel that the author completely misunderstands Hamilton's contributions to the principle of least action. He writes, describing the focusing effect of an electric or magnetic field on electron beams: "In a most elegant manner it was now possible to make a direct application of the theory developed by William Korvan Hamilton in 1831 to the trajectory of an electron in the electromagnetic field of an electron optical system. The 'Hamiltonian analogy' described the path of light rays through media with continuously varying refractive index in terms of the trajectory of material particles in potential fields." It seems that, here and later, the author's emphasis is on the continuously varying refractive index; whereas to me, at least, the basic feature of Hamilton's method in optics is the reconciliation of a minimal principle (least action or Fermat's principle) with a contact transformation (construction of Huygens), and the carrying over of this fundamental duality into dynamics.

A little later the author states flatly that in contradistinction to light optics, which has both convergent and divergent lenses, electron lenses having axial symmetry can only be convergent. The level of presentation alternates between the relatively low and the moderately advanced, so for instance on page 19, in explaining the light microscope, the author finds it necessary to go into explanation of actual distances and focal length used in this instrument and fails to discuss in any manner the resolution of the instrument. Yet on the following page, in using the electron microscope, he states, "The higher resolution available with electron optics does permit higher useful magnification". A discussion of the resolving power of the microscope starts on page 36 and un-

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When I began reading the first chapter of this book, the first idea was that the proofreading was inadequate. Nevertheless, as I went along I had to revise this opinion. I really cannot blame the proofreader for the very inaccurate style and mistakes of the author. I mentioned earlier the misuse of Hamilton's name. Huygens is mistreated constantly, being called Huygen without an "s". There are many sentences where pronouns are missing or where obscure references are made to a much earlier sentence. Take for instance this example, "taking the Rayleigh criterion that the image figures are to be separated so the maximum of the second falls at the minimum of the first". At the beginning of the long paragraph preceding this one, the author said that he is speaking of the images of two self-luminous points. Another example, "the critical lenses of the electron microscope in general use today are magnetic lenses." I understand the word "critical" is used in the sense of important, but I understand it only because I am familiar with modern electron microscopes.

It is a pity that an otherwise very useful compilation of the elements of electron microscope optics is marred by so many little faults. Quite a bit of the information contained in the article is very useful, and the references contain a good introduction to the general literature, of which the user of the electron microscope can take advantage.

Dr. Pashley's contribution on the application of the electron microscope in physics in limited to the observation of crystalline structures in transmission, a field with which the author is thoroughly familiar. It is a very good presentation of this growing field, extending over more than one hundred pages and a bibliography containing 126 references. My only objection is that it gives the impression that observation of thin crystals in transmission is the only application of the electron microscope in physics, which I hope is not the case.

The remainder of the book is on selected methods and techniques, such as thin metal specimens, particulate

materials, ultramicrotomy, as well as such applications of the electron microscope as those in histology, cytology, bacteriology, and studies of biological macromolecules. The printing is very good and the many microphotographs are excellent illustrations of the fields represented.

Heidenreich's book is an excellent workmanlike presentation of transmission electron microscopy, and I would like to quote from the author's preface: "My rather ambitious intent is to develop a coherent, physical approach to the understanding of contrast in electron microscope images whether the objects are plant cell walls or crystals containing stacking faults."

After a 15-page historical introduction, the author discusses the ideal or Gaussian images, different aspects of electron scattering in the object, and continues with electron diffraction and a diffraction-induced contrast in the electron microscope image. The aim of the author, to produce a unified viewpoint for the description of contrast both in the amorphous and crystalline media, is an extremely laudable one. The question may be raised how far he succeeds in that attempt. I, for one, would like to encourage him to persevere because I do not believe that he really entirely covered the ground. I may be wrong in believing that for the time being all amorphous substances are still best described by the scattering or what Heidenreich calls "mass thickness" approach. Since he presents both approaches very adequately, the reader has the choice of the approach he prefers to use for his own data.

Before reading Heidenreich's book I was convinced that Pashley gave the best presentation of the whole field of diffraction contrast. Now I have to modify that opinion. Both have done excellent jobs and for those who prefer a condensed version I would recommend Pashley's work; for the more extended treatment Heidenreich is the proper place to look.

A few minor things may be criticized in the book. The general references are limited in their entirety to English-language presentations. Much later in the text, reference is made to some non-English literature. This is a little regrettable, because I believe that the references to the monumental work of Glaser, to that of von Laue, and to the excellent encyclopedia article of Leisegang really belong in the general references. I fail to understand figure II-11 on page 58. The caption is inadequate to distinguish which are the elastic and inelastic curves and the notation "Q_{e1}" is not explained. The footnote on page 103 refers to photons and not to electrons. These are such minor blemishes that they do not at all mar an excellent book. I would like to mention one more thing which pleased me no end in reading this book. It is dedicated to the memory of C. J. Davisson. All of us who have known Davisson, his wonderful contributions to physics, and his extremely lovable personality, will greet this dedication as a most fitting tribute to his memory.

An Introduction to Modern Physics. H. Messel and S. T. Butler, eds. 273 pp. St. Martin's Press, New York, 1964. $5.00. *Reviewed by Robert L. Weber, The Pennsylvania State University.*

According to a note on the dust jacket (there is no Preface), this book is a record of a series of lectures given to science teachers by world experts at the *third** Nuclear Research Foundation Summer School in Australia. It is not mentioned that all of the chapters were previously published (1961) by the Shakespeare Head Press, Sydney, Australia, in *Space and the Atom,* a record of the *fourth** Nuclear Research Foundation Summer School for Science Teachers held at the University of Sydney in January, 1961, which also included a chapter on particle accelerators and sections on radio astronomy and aeronautics. The St. Martin's Press has apparently chosen to make their book smaller and more coherent by omitting these six chapters.

Professors S. T. Butler and H. Messel, of the University of Sydney, present in seven chapters a conventional, nicely organized introduction to the Rutherford atom, radiation, relativity, and nuclear reactions. Professor E. E. Salpeter, of Cornell University, starts his three chapters with the remark "Most laymen who are acquainted with modern physics shudder at the mere mention of the words Quantum Mechanics." Then in relatively easy steps he explains the significance of Planck's constant, the empirical concepts of wave mechanics leading to "the famous Schroedinger wave equation, written out in its full glory", and applied to the hydrogen atom. In three short chapters, Professor C.B.A. McCusker, of the University of Sydney, discusses present views on stable particles, mesons, strange particles, and force fields. He points out that "in the end we have had to interpret the particles in terms of fields, which, though quantized, are continuous. And fields pass through the most complete vacuum. In fact, the atoms are not sharply bounded and the void has a definite structure. So it seems that the argument [is matter continuous or discontinuous?] is being resolved as we resolved the argument as to the wave and particle nature of light. We must combine both ideas to make sense of the experiments." Professor W. Boas, of the University of Melbourne, deals with solid-state physics in chapters on crystals and the properties of solids, conduction of electricity, and crystal defects and the strength of materials.

The authors are not at all condescending toward the science teachers for whom these lectures were prepared. Yet the demands made upon them are not unreasonable. The reward should be a substantial understanding of the concepts and methods of modern physics. Throughout the book there is a clarity and coherence especially to be commended in a multiple-author project.

*According to St. Martin's Press, their dust-jacket note is in error. Both books refer to the *fourth* summer school. ED.

The Mathematics of Physics and Chemistry, Volume 2. By Henry Margenau and George Moseley Murphy. 786 pp. Van Nostrand, Princeton, N.J., 1964. $15.00. *Reviewed by J. Gillis, Weizmann Institute of Science.*

Volume 1 was a systematic exposition of mathematical techniques with physics and chemistry merely providing illustrative examples. Volume 2 is completely different in spirit, being, in fact, rather a collection of short monographs in theoretical physics.