

"Electrical Measurements"? In the same class are the chapters on "Electronic Circuits" and on "Vacuum Techniques" mentioned earlier, as well as those on "Photometry and Illumination," and on "Accelerators." Such subjects might be reserved for a future handbook of applied physics, in which they could receive more complete attention.

The opposite conclusion might be drawn in regard to the chapters on branches of mathematics, where in a handbook of physics, a strong emphasis on applied mathematics (as this term is used by mathematicians), rather than on pure mathematics, would appear to be desirable. To be sure, there are very good chapters on "Analysis" and on "Numerical Analysis," by John Todd, on "Tensor Calculus" by Cornelius Lanczos, and on "Probability Theory" by C. E. Eisenhart and M. Zelen, but not all of the remaining chapters on branches of mathematics appear to be of comparable relevance to a handbook of physics.

This edition of the handbook contains a very extensive and carefully prepared index, with far more entries than the first edition. The typography and illustrations are excellent. On the whole, the publication of this revised edition of a highly regarded and useful book should be welcomed by the physics community, as well as by scientists generally.

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Phase shifts

VARIABLE PHASE APPROACH TO POTENTIAL SCATTERING. By F. Calogero. 244 pp. Academic Press, New York, 1967. \$11.50

by John L. Gammel

It is hardly necessary to review this delightful book in much detail. It can be read through very rapidly so that anyone interested in scattering theory will be able to judge its value to himself almost immediately.

The book starts with a derivation (from the Schrödinger equation) of a first-order differential equation for a quantity $\tan \delta(r)$ (the tangent of the phase shift resulting from a potential truncated at r , or, what is the same thing, the contribution to $\tan \delta$

resulting from that part of the potential lying between 0 and r), and similar equations for $\delta(r)$, or $S(r)$ [the S matrix $\exp(2i\delta)$], or the scattering amplitude $A(r)$. The advantage of the method is that it deals directly with a quantity of physical interest; namely, the phase shift, or at any rate a simple function of the phase shift. The method can be described as an imbedding method since the phase shift for many potentials (obtained by many different truncations of a single potential) are calculated simultaneously.

Then special subjects are treated: bounds on the phase shift and its variation with energy, Born approximation and a scheme for improving it, variational principles, simultaneous maximum and minimum principles, singular potentials, scattering by Dirac particles, scattering by nonlocal and complex potentials, multichannel scattering, poles of the S matrix and Levinson's theorem.

The author states in the preface that "... this method of discussing scattering phase shifts should be introduced in all elementary quantum mechanics courses that include a treatment of scattering theory." This statement may be true; I recommend that all teachers of such courses look at the material and form their own judgments.

It is more difficult to estimate the value of the method in advanced research. My guess would be that as a practical computing device, the method has no advantage over more usual techniques; in fact, $\tan \delta(r)$ is a spectacular function of r for some potentials and some energies as can be seen by inspecting the figures in the book. But this question is beside the point; the questions of principle that can be decided by the method are of more interest. Many interesting results on the poles of the S matrix and Levinson's theorem are obtained by elementary methods. I wondered if it might be possible to prove the convergence of the Padé approximants to the Born series for $\tan \delta$ by this method. This possibility presents itself because the first-order differential equation derived for $\tan \delta$ is a Riccati equation. No doubt other applications will present themselves to other researchers.

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Toward a unified science of materials

STATISTICAL MECHANICS, THERMODYNAMICS AND KINETICS. By Oscar K. Rice. 586 pp. W. H. Freeman, San Francisco, 1967. \$12.50

by Herman A. Liebhafsky

In the preface to his *Statistical Mechanics*, J. Willard Gibbs wrote: "Moreover, we avoid great difficulties when, giving up the attempt to frame hypotheses concerning the constitution of material bodies, we pursue statistical inquiries as a branch of rational mechanics . . . Difficulties of this kind have deterred the author from attempting to explain the mysteries of nature." A successful fusion of statistical mechanics, thermodynamics, and kinetics—the consummation wished for above—would be a great step toward such an explanation, and it would be evidence that a single, unified materials science might someday exist. Fusion of the first two disciplines is well under way, but kinetics is certain to prove refractory because it deals with systems that usually change with time at rates that neither statistical mechanics nor thermodynamics can now reliably predict.

The author is Kenan Professor of Chemistry at the University of North Carolina. He has done distinguished work in each of the three disciplines in his book. Because of the difficulties associated with kinetics, it is fortunate that he has long been an authority in this field.

The book is intended primarily for chemists in their senior and graduate years. To an unusual and welcome degree, it bears the impress of its author. Again to an unusual and welcome degree, conclusions from statistical mechanics are compared with experimental results. Many searching questions and testing problems are included.

In most "statistical inquiries as a branch of rational mechanics," the approach to "rational thermodynamics"—another of Gibbs's phrases—is by way of Boltzmann's H theorem through the partition function and entropy to the Helmholtz free energy. The author, following the lead of W. F. GIAUQUE, in a sense reverses this approach in chapters 2 and 3. He begins with the Gibbs free energy, which is simply related to the

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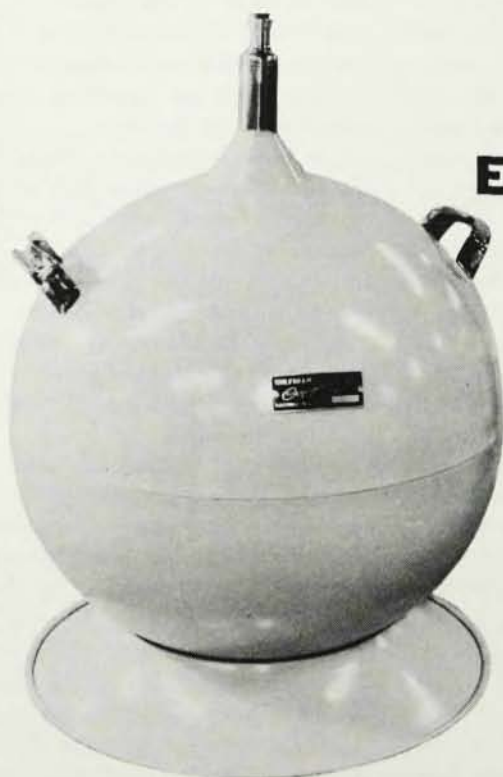
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equilibrium constant, and applies it to the internal motions of the molecules in an ideal gas. For such motions the two free energies are identical. This reversed approach, perhaps more familiar to chemists than to physicists and perhaps less elegant than Gibbs's, proved its value long ago in the calculation begun by Giauque of thermodynamic from spectroscopic data; the author has carried it much further. The physicist interested in chemical (as contrasted with physical) changes will find it worth his while to become familiar with chapters 2, 3 and 4 even though these presuppose a prior knowledge of the language of chemical thermodynamics.

Among topics directly interesting to most physicists are the classical treatments of ideal and imperfect gases, order-disorder phenomena and liquids, and the quantum treatment of these same substances with emphasis on liquid helium. A chapter of about 40 pages is given over to the solid state, mainly to the Einstein and Debye models. The Debye model for solid argon is carefully tested against experimental data.

A book of this length cannot hope to embrace much of chemical kinetics. The theoretical groundwork for the prospective fusion of this subject with the other two disciplines is laid; but the author considers the calculation of activation energies, an important activity carried forward particularly by Henry Eyring and his coworkers, to be outside the scope of his book. The preexponential factor in the expression for the rate constant receives full attention. Recombination of atoms, dissociation of diatomic molecules, and unimolecular reactions are the principal reactions discussed, again with careful comparison of theory and experiment.

As this book and numerous related books make clear, modern statistical mechanics has set itself a goal much more ambitious than that of Gibbs, who was faced by difficulties that quantum theory has resolved. The goal might be described as understanding Gibbs's "mysteries of nature" completely enough so that reliable predictions can replace experiments. With computers available, is this a realistic goal? How far along the road are we now? The author's opinion on such general questions would have been valuable.

I believe that this book will prove

difficult for undergraduates. I recommend it strongly for advanced study. Although it does not include some material of particular interest to physicists (for example, a discussion of metals and semiconductors), it may be regarded as required reading for physicists seriously interested in chemical reactions.

* * *

After a long research career in the General Electric Company, Herman Liebhafsky resumed academic work last year and is now professor of chemistry at Texas A & M University. He has been concerned with thermodynamics and kinetics for about 40 years.

Points for graduate students

DEFAUTS PONCTUELS DANS LES METAUX. By Y. Quéré. 236 pp. Masson, Paris, 1967. 80 F.

by Daniel C. Mattis

The topic of point defects in metals is reviewed exhaustively in this volume, one of a series of monographs happily aimed at the graduate student. What in an ordinary book would be a stern collection of formulas and references is here filled out with explanations and derivations that are not only helpful to the student, but help the researcher to understand the limits of validity of the theory being discussed.

The application of each theory to experimental data is carried out in almost every chapter. The reader is provided with an elementary, but adequate, review of elastic theory of defects, atomic models, potential and phase-shift theory, thermodynamics of point defects (equilibrium and metastable) point defect generation, diffusion and effects on electrical and other properties of the metal. The author shows a good grasp of the large number of metallurgical and physical disciplines coordinated into the present work. Although one would not turn to this book for authoritative, deep, or new insights into any of the main topics considered, a student would find the book indispensable prior to commencing serious study or research involving point defects. In the preface, the series editors (P. Aigrain, A. Blanc-Lapierre, M. Levy and J. Friedel) state: "We think there is room in France for a new collection of this type, presenting limited

topics which are of up-to-date interest to readers with a good general background in modern physics." I would merely add: there is room for such a collection here too!

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Daniel C. Mattis is professor of physics at the Belfer Graduate School of Science, Yeshiva University, and has done research on several aspects of the physics of metals.

In the matter of materials

MATERIALS: A SCIENTIFIC AMERICAN BOOK. 210 pp. W. H. Freeman, San Francisco, 1967. Cloth \$5.00, paper \$2.50

by L. Marton

Cyril Stanley Smith, whose outstanding contributions to our knowledge of materials are well known, introduces this volume, a reprint of the September 1967 issue of *Scientific American*. There is perhaps no better way to characterize his attitude toward the whole subject than by a quotation from the May 1968 issue of *Science and Technology*. There Smith says: "The discovery of most metals and alloys came out of aesthetic curiosity—not intellectual—and the first beginnings of science led away from the enjoyment of the wonderful qualities of materials; but I think this is now coming back." The lead article by Smith in the present volume gives a delightful introduction with plenty of historical material on the study of materials.

The compilation contains altogether thirteen chapters, each written by an outstanding authority of the subject treated. These chapters are as follows: Smith, "Materials;" Nevill Mott, "The Solid State;" A. H. Cottrell, "The Nature of Metals;" John J. Gilman, "The Nature of Ceramics;" R. J. Charles, "The Nature of Glasses;" Harman F. Mark, "The Nature of Polymeric Materials;" Anthony Kelly, "The Nature of Composite Materials;" John Ziman, "The Thermal Properties of Materials;" Henry Ehrenreich, "The Electrical Properties of Materials;" Howard Reiss, "The Chemical Properties of Materials;" Frederick Kefauver, "The Magnetic Properties of Materials;" Ali Javan, "The Optical Properties of Materials," and W. O. Alexander, "The Competition of Materials."

All the articles are very concise,