
BOOK REVIEWS

An Introduction to Statistical Thermodynamics. By TERRELL L. HILL, Department of Chemistry, University of Oregon. Addison-Wesley Publishing Co., Inc., Reading, Mass. 1960. xiv + 508 pp. 16 X 23.5 cm. Price, \$9.75.

Here is a new introductory treatment of the statistical mechanics of equilibrium systems, written by a chemist who is well known for his research work in applied statistical mechanics. It is intended as a textbook, primarily for physical chemists. The major purpose of the book is to cover extensively the main active fields of application of equilibrium statistical mechanics, and to give only an introduction rather than a highly refined, elaborate theory of each topic. The treatment of fundamentals is therefore comparatively brief, and most of the book is devoted to the applications, for which usually a sort of first-order approximation is given. This statement may suggest that the treatment is superficial, but it is not. The author keeps each topic well in hand, displays plenty of physical insight into the nature of each problem, frequently pauses to make estimates and checks of orders of magnitude, and often indicates the direction to be taken in a more refined theory. Problems at the end of each chapter appear sensible and useful. Most of them give the impression of having been used, and not just thrown in as an afterthought. Many of the applications refer to work of the last decade, and probably appear for the first time in an introductory text. The more traditional material on the calculation of thermodynamic functions from spectroscopically determined energy levels is still present, but is not emphasized.

Probably not all readers will agree with Hill's approach. Some may prefer a more thoroughgoing treatment of the foundations of the subject, and some may prefer to see only a few applications considered, but each one treated in greater depth. This is probably largely a matter of individual taste, and each reader will have to decide for himself on these matters, but most will no doubt agree that the author has done an outstanding job within the limits he has set for himself.

The book is divided into four parts, of which Parts I and IV cover the principles, and Parts II and III the applications. Parts I and IV are relatively short, consisting of two chapters and one chapter, respectively. Chapter 1 is concerned with the fundamental postulates of statistical mechanics, and the development is based on very elementary quantum mechanics (about all that is required is a familiarity with the notions of energy levels, discrete quantum states, and the like.) Classical statistical mechanics appears only as a limiting case of quantum mechanics. This approach is now quite common, and everyone seems to agree that it is in fact the simplest. Not so common is the immediate introduction in Chapter 1 of a variety of ensembles, but there is much to be said for this approach, since many problems are much more easily treated by, say, the grand canonical ensemble than by the microcanonical ensemble. Having introduced different ensembles, the author feels free in later chapters to use whichever ensemble best suits the problem of the moment, and he does so with considerable skill. Chapter 1 is perhaps the most difficult in the book, because all the fundamentals are presented in such a short space. The author is aware of this, and in the preface states, "It may be wise for the average student to return to this chapter for rereading after having acquired some familiarity with applications in later chapters." This reviewer heartily seconds the motion.

Chapter 2 gives the reader a breather after the hectic pace of Chapter 1, even though its first topic is rather unusual in a second chapter. Fluctuations are discussed, and used very effectively to give some physical insight into the results of Chapter 1, and to demonstrate that the calculation of thermodynamic properties is unaffected by the choice of ensemble, which may then be chosen for purely mathematical convenience with a clear conscience. Part IV is a single chapter on standard quantum statistics. Its sections could have been distributed in various places throughout the book, and some teachers may prefer to do so.

Part II (eleven chapters) deals with applications to systems composed of sets of independent subsystems, and takes up general relations, ideal monatomic, diatomic and polyatomic gases, monatomic crystals, simple lattice statistics, chemical equilibrium and reaction rates (quasi-equilibrium Eyring theory) in ideal gases, ideal gas in an electric field, and polymer configurations. The maximum term method is used throughout in all derivations, which leads to difficulties over Stirling's approximation only for systems of indistinguishable molecules. At this point the names of Darwin and Fowler are invoked, never to appear again. This was the only place in the book where the reviewer felt rather cheated. Part II also includes a brief chapter on classical statistics. Part III (eight chapters) deals with systems of interacting molecules, and takes up lattice statistics, imperfect gases, cell and hole theories of liquids, distribution functions of fluids, dilute electrolyte solutions (including plasmas!), dilute and concentrated liquid solutions, and polymers and polyelectrolyte solutions and gels.

In summary, this is a book which treats the fundamentals adequately and the applications superbly. Many of the innovations in treatment and order of topics are likely to become standard for teachers and future textbook writers. For a first course in statistical mechanics for physical chemists, either one or two semesters, this text can be recommended enthusiastically.

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Gmelin's Handbuch der Anorganischen Chemie. Achte Völlig Neu Bearbeitete Auflage. Cadmium. Ergänzungsband. System-Nummer 33. Edited by E. H. ERICH PIETSCH. Verlag Chemie, G.m.b.H., Pappelalle 3, Weinheim/Bergstr., Germany. 1959. xciv + 802 pp. 17.5 X 25.5 cm. Price, kart., DM. 508. —; ganzl., DM. 513. —.

In these days when chemists are trying desperately to cope with the explosive growth of the chemical literature, more and more reliance must be placed on reviews and handbooks. One of the very bright spots in this picture is the availability of Gmelin's Handbuch der Anorganischen Chemie. Making excellent use of the German talent for thorough and painstaking compilation, organization, and critical evaluation, Dr. E. H. Erich Pietsch of the Gmelin Institut directs a most effective operation for producing the Eighth Edition of this encyclopaedic work. In the treatment of each element all of the references discussed in earlier volumes are being reviewed in the light of modern developments and each section is being made complete up to the date indicated.

In 1959, the treatment was further amplified for the convenience of English-speaking users by printing the comprehensive tables of contents in both German and English and by the lavish use of English headings and sub-headings in the margins of the text. The English-speaking reader, even with very little facility in reading German, will find the use of this Handbuch very easy.

The full effectiveness of the new bilingual format is demonstrated admirably by the new Supplementary volume on cadmium, which offers complete and critical literature coverage up through 1949, and which supersedes the earlier main volume on cadmium which appeared in 1925. The tremendous growth of the literature on cadmium in the 25 year interim is witnessed by the nearly fourfold increase in pages. The well-organized 94 page German-English Table of Contents of this new volume affords in itself a rapid over-all picture of the full range of the chemistry of cadmium. In the 802 pages of text that follow, lavish use of diagrams and tables help to summarize the data. My random sampling of the coverage of specific topics with which I am familiar fully substantiates the completeness and critical evaluation of the data from the literature. In addition to complete coverage of the fundamental material, very extensive at-

tention is given to the technology of cadmium. A plan already is being activated to extend the coverage in the Gmelin's Handbuch for the decade 1950-1960, with publication of new volumes to start about three years from now.

Gmelin's Handbuch should be the nucleus of the inorganic chemical collection in every academic library. Students should be introduced to it as early as possible and encouraged to use it, rather than placing full reliance on abridged handbooks and textbooks. Likewise it should be made the inorganic keystone in every industrial scientific library, and industrial chemists should take advantage of the wealth of reliable information it affords.

We chemists owe a great debt to Dr. Pietsch and the Gmelin Institut for the production of this most excellent reference work. The project deserves generous support by the widespread purchase of the Handbuch and by other means so that the Eighth Edition can be completed and the work of producing supplementary volumes for the 1950-1960 decade can be expedited. This reviewer can think of no better investment of funds to further science.

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Metallurgy of the Rarer Metals. Number 7. Beryllium. By G. E. DARWIN, M.A., A. Inst. P., A.I.M., and J. H. BUDDERY, B.Sc., Ph.D., A.R.C.S., D.I.C. Academic Press Inc., 111 Fifth Avenue, New York 3, N. Y. 1960. ix + 392 pp. 14.5 × 22.5 cm. Price, \$13.50.

Previous volumes in this series have covered chromium, zirconium, manganese, titanium, molybdenum, and tantalum and niobium. The present volume on beryllium maintains the same high standards as the earlier ones. Ten years ago chromium was considered to be "inherently brittle." The first volume in this series, "Chromium" by A. H. Sully (1954), helped to dispel this aspersion. While the brittleness of chromium remains a fabrication problem, it is now known that high-purity chromium can be made in forms that are ductile from sub-zero temperatures upward, and that the ductility at room temperature can be quite high. Nitrogen, particularly in the surface layer, is now known to be the main embrittling impurity [cf. *Metallurg. Revs.*, 4, #16, 434 (1959)]. The question as to whether impurities cause the poor ductility of beryllium remains unanswered, and according to the author of this Volume 7, will continue to be raised until really pure metal has been prepared and tested.

The development of beryllium metal in tonnage quantities goes back to 1942 when its use in nuclear reactors was desired because of its low capture cross section for thermal neutrons, its high elastic modulus and its good thermal conductivity. This development was impeded by the poor mechanical properties it exhibited, although it has been used extensively in reactor components that are not subjected to high stresses. That there is some hope of overcoming the brittleness of beryllium, just as this was accomplished with chromium, is seen in a statement quoted from page 145: "Difficulties in the fabrication of beryllium shapes are being overcome and the present emphasis is on improved mechanical properties. Joining technology is one step behind..." Much remains to be done to improve production and fabrication processes, to lower the impurity content, and to make finished shapes while retaining optimum strength and fatigue characteristics. In addition to use in nuclear reactors, beryllium has been considered favorably for space vehicle applications because of its low density, corrosion resistance, and high strength-to-weight ratio. In spite of the great interest in beryllium, production of beryllium (roughly 5% Be) reached a figure of only 12,000 tons a year in 1956. The 1959 production of metal in the United States was only about 70 tons, with a price ranging from \$50 to \$200 a pound, depending on the form. From these facts, it can be surmised that beryllium can never become a large tonnage metal.

Besides the production, fabrication and a correlation of resultant mechanical properties of beryllium metal, this book summarizes the preparation of beryllium oxide from beryl and the fabrication of beryllia ceramic shapes; the physical, nuclear and chemical properties of the element; and the characteristics of its alloys, both those in which it is a major as well as those in which it is a minor component.

The discussion is concluded with a ten-page review of the toxicity of beryllium compounds and methods to control the very serious hazards presented in large scale operations involving beryllium.

Like the other volumes in this series, Volume 7 consists essentially of an annotated bibliography with interpolated comments to bind it into a coherent whole. The result is a very readable, concise, and up-to-date (into 1959) review of one of the potentially most important structural metals of the space age.

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Optische Daten zur Bestimmung anorganischer Substanzen mit dem Polariationsmikroskop. Mit einer Einführung in die kristall-optischen Arbeitsmethoden. By Dr. ERNST KORDES, o. Professor für Strukturchemie an der Universität Bonn. Verlag Chemie, G.m.b.H., Pappelallee 3, Weinheim/Bergstr., Germany. 1960. xi + 191 pp. 17.5 × 24.5 cm. Price, DM. 43.—.

This book is intended for those who use the polarizing microscope for the identification of inorganic substances, especially in powder form. There is a concise description of the methods of chemical microscopy, beautifully illustrated by two color plates.

The outstanding features of the book are the tables and charts which greatly facilitate systematic identification of unknown materials. Approximately 1300 inorganic compounds are arranged in two principal ways: as a table of substances and tables of constants.

In the table of substances, there are separate listings for substances that are optically isotropic, uniaxial positive, uniaxial negative, uniaxial with unknown sign of the double refraction, biaxial positive, biaxial negative, and biaxial with unknown sign of the double refraction. The arrangement is in order of increasing value of the highest refractive index. The table lists the name and formula of the substance, a key number for use in other tables and diagrams, color, crystal system, refractive indices, density and references to the literature.

The tables of constants list data as determined with the polarizing microscope as follows: refractivity, magnitude and sign of the double refraction, color and pleochroism, and the formula and key number of the substance. These tables have the same arrangement as the table of substances except that each anisotropic substance is listed in two tables, once in a table of increasing refraction for the extraordinary ray, and once for increasing refraction for the ordinary ray.

The diagrams give, in graphic form, plots of double refraction vs. refractive index for the various anisotropic substances, and plots of density vs. refractive index.

There is a list of mineral names and an alphabetical formula index.

The practicing microscopist will find this book of great value, and institutions that offer instruction in microscopy may well use it to supplement standard text-books.

In addition, this volume so increases the usefulness of the polarizing microscope as an analytical tool that many who are now unfamiliar with this technique may be encouraged to use this versatile micro-method.

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Solid State Physics. Advances in Research and Applications. Volume 10. Edited by FREDERICK SEITZ, Department of Physics, Univ. of Illinois, Urbana, Illinois, and DAVID TURNBULL, General Electric Research Laboratory, Schenectady, New York. Academic Press Inc., 111 Fifth Avenue, New York 3, N. Y. 1960. xv + 516 pp. 16 × 23.5 cm. Price, \$12.00.

Almost half of this volume is devoted to an article by M. R. Schafroth entitled "Theoretical Aspects of Superconductivity." The earlier sections of Dr. Schafroth's review constitute a terse but lucid exposition of the problems to be faced in developing a general theory of superconductivity and an account of early efforts at their solution.