BOOK REVIEWS

Physical Chemistry. By A. J. RUTGERS, University of Ghent. Interscience Publishers, Inc., 250 Fifth Avenue, New York 1, New York. 1954. xviii + 804 pp. 16 × 23.5 cm. Price, $8.50.

In many respects, this book is scholarly, interesting and appealing. Its style is clear and readable. The author has successfully lightened abstract discussions by introducing amusing and informal analogies. The basic concepts of theoretical chemistry are covered as thoroughly as space permits. A few sections, such as chapter 5, are outstanding for their clarity and completeness. In spite of its many virtues, the reviewer believes that this book will not be generally useful to American students of Physical Chemistry.

A number of aspects of Physical Chemistry of great practical importance are either omitted or are dealt with briefly and casually. Ionic equilibria are scarcely mentioned. The concept and use of transport numbers of ions is omitted. The treatment of galvanic cells is brief and unconvincing. Subjects such as chromatography and polarography are not presented.

The treatment of classical thermodynamics, which occupies about two hundred pages, is basically sound and readable, but it is not elegant, nor practical (in the sense of being readily applicable to real problems), nor especially rigorous. Cycles and hypothetical engines are used frequently in derivations. The terms and symbols used resemble, but in important respects differ from, Guggenheim's system.

The chapter on reaction velocity is somewhat disappointing. The presentation is largely historical; a full page is devoted to the long-since discredited radiation hypothesis and only two and a half pages to Eyring's transition-state theory. Many of the experimental results which are introduced into this section appear to have been selected at random without regard for their intrinsic interest or importance.

The last two chapters, on The Atomic Nucleus and The Physical Chemistry of High Polymers, are largely descriptive outlines and appear out of place in this theoretical volume.

The binding, paper and typography are good. However, the index leaves much to be desired. There are too few subheadings following major entries; frequently an item is followed by eight or ten undifferentiated page references. The lack of cross references is particularly troublesome, since the terms used often diverge from American conventional usage.

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The Theory of the Photographic Process, revised edition. By C. E. KENNETH MEES, D.Sc., F.R.S., Vice President in Charge of Research, Eastman Kodak Company. Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. 1954. x + 1133 pp. 16.5 × 23.5 cm. Price, $21.50.

The first paragraph of the preface to this book provides a concise review of the purpose of the book—"During the last fifty years, scientific workers interested in the study of the photographic process have built up a fund of knowledge which is scattered through the literature in several languages and in a great diversity of journals. The purpose of this book is to provide a general handbook of the subject as a guide to the literature and as a summary of its conclusions."

For one not intimately familiar with the photographic process it would be difficult to imagine how so much could have been written on one specialized subject. There are 1087 pages in the book, five parts and twenty-five separate chapters. Each chapter has an extensive list of references—a short chapter will have approximately twenty-five references and some of the longer chapters as many as one hundred and fifty.

The book was in part written or edited by several members of the Research Department of the Eastman Kodak Company. It is a completely revised and largely rewritten 2nd edition of the book published in 1942 under the same title. The five sections and their "editors" are

Part I.	The Photographic Material J. A. Leermakers
Part II.	The Action of Radiation J. H. Webb
Part III.	Optical Sensitizing B. H. Carroll and L. G. S. Brooker
Part IV.	Development and the After-Processes T. H. James and A. Weissberger
Part V.	The Physics of the Photographic Process L. A. Jones

The book is no book for a casual reader. Each section is written by an expert who has spent a large share of his professional life on the problem about which he writes. Each chapter contains such a mass of detail that for the casual reader it would be dull reading. On the other hand, for those vitally interested in a subject covered by the book, it will be delightful to find such complete coverage.

Each topic is summarized sufficiently in the text so that a reader can get oriented. Usually, however, it will be necessary to consult the original papers for complete understanding.

There are many sections of this book that should provide a valuable source of information for chemists. There are chapters on Gelatin, Sensitizing, and Desensitizing Dyes, Mechanism of Development, Developing Agents and Their Reactions, Kinetics of Development, Electrochemistry of Developers. Anyone using photographic films for photometry can find a detailed discussion of the relation between Exposure and Density, Reciprocity and Intermittency Effects. There is also a chapter on the Action of Charged Particles on the Photographic Emulsion.

This book presents a good object lesson to persons concerned with the "overproduction" of scientific personnel. Here we see what a vast amount of work has gone into one subject, Photographic Theory. And yet, detailed investigation reveals that in almost every field discussed in this book there are vast areas not yet understood. This book will serve as a priceless reference for the army of investigators that will be needed in the future before the subject is fully understood.

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X-Ray Diffraction Procedures for Polycrystalline and Amorphous Materials. By HAROLD P. KLUG, Head of the Department of Research in Chemical Physics, and LEROY E. ALEXANDER, Senior Fellow in X-Ray Diffraction, Mellon Institute. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. 1954. xiii + 716 pp. 16 × 23.5 cm. Price, $15.00.

The ever increasing application of X-ray diffraction analysis in industrial research and control has encouraged the two authors to prepare this comprehensive and valuable book on the diffraction of X-rays by polycrystalline and amorphous materials. They omit from consideration the discussion of single crystal analysis except as background for their special interest.

The needs of the complete beginner in the field are catered to by the first three chapters which contain clear and well written summaries of the elements of crystallography, the physics and engineering of X-ray production and the principles of X-ray diffraction.

The next five chapters give a complete and very detailed account of the available powder techniques using both the photographic and Geiger counter spectrometer methods for collecting data. These chapters cover more than three hundred pages and form the backbone of the book. Many hundreds of X-ray workers, technicians and their bosses,

will be grateful to the authors for the great pains they have taken in detailing all the steps that must be taken in accumulating accurate powder data and in extracting the most useful information from that data. No step in the procedure is so simple that they leave it out and none is so complex but that they attempt a clear and lucid explanation of it. Nothing is as good as an experienced instructor, but this book is certainly the next best thing, and the experienced instructors themselves will make much use of it.

The last four chapters cover, in the same admirable style, some of the more specialized techniques such as particle size from line-broadening, stress measurement, preferred orientation, radial distributions, and finally small angle scattering. Appendices cover the equipment of a laboratory and its processing rooms.

Not the least valuable are the vivid illustrations. Some are photographs, many are excellent sketches which illustrate intricate points of technique. There are countless practical examples and useful tables in the appendices and in the text.

This book is a must for every laboratory working in this field. It will probably not be read through by many, but each group will blacken its own particular set of pages with the thumb marks of constant reference.

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Molecular Theory of Gases and Liquids. By JOSEPH O. HIRSCHFELDER, Department of Chemistry and Naval Research Laboratory, University of Wisconsin, CHARLES F. CURTISS, Department of Chemistry, and Naval Research Laboratory, University of Wisconsin, and R. BYRON BIRD, Department of Chemical Engineering, University of Wisconsin. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. 1954. xxvi + 1219 pp. 16 × 23.5 cm. $20.00.

This book is one of encyclopaedic dimensions; yet, on reading it, one gains the impression that it is compressed. Even for a book of 1200 pages it contains a great amount and a great variety of material. It is divided into three parts—one on the equilibrium properties of gases and liquids, one on the transport properties, and one on intermolecular forces—any one of which could comprise a volume in itself.

The first chapter of the book is an introduction to the three parts mentioned above. It contains a very elementary account of the equation of state and of the kinetic theory of gases, the latter based upon a model which does not consider the distribution of velocities, a brief discussion of the methods used in the more rigorous theory, an outline treatment of intermolecular forces, a discussion of classical mechanics with particular attention to molecular collisions, and an introduction to quantum mechanics.

Part I starts with a chapter on statistical mechanics. The next chapter is a discussion of the equation of state of dilute gases, with particular emphasis on the calculation of second and third virial coefficients for a considerable variety of intermolecular potentials, using the cluster integral methods. This is followed by a treatment of dense gases and liquids, starting with various empirical equations and a discussion of the principle of corresponding states, and including discussions of cell theories, hole theories and the radial distribution function. There is then a chapter on the equilibrium between liquid and vapor, including a discussion of surface tension. Quantum theory and quantum effects at low temperatures are considered in a special chapter by J. de Boer and R. B. Bird.

Part II deals with the transport properties of gases, a large portion of it being devoted to what is generally called the kinetic theory of gases. It is based for the most part on the Maxwell-Boltzmann equation and the various equations of change and of continuity, essentially no use being made of the mean free path. Frequent reference is made to Chapman and Cowling's "Mathematical Theory of Non-Uniform Gases," which gives a more detailed account of many of the topics treated, but which is, of course, not as up-to-date as the book under review. The latter, for example, makes some reference to the statistical mechanical theory of non-equilibrium processes which is being developed by Kirkwood and his collaborators. A vector and tensor notation is used in this part of the book, this notation being explained, somewhat inadequately in my opinion, in a section at the beginning of the book. A reader who is unfamiliar with, or rusty on, this notation will do well to first read Chapter 1 of Chapman and Cowling, noting some slight differences. In the chapter on dense gases and liquids the more sophisticated treatment is supplemented by a discussion of Eyring's theory of viscosity and other transport phenomena and an Appendix gives a brief account of the activated-complex theory of reaction rates, upon which this theory of viscosity is based. Incidentally (though not too important for the purposes of the book as a whole), this Appendix quotes approvingly Gershinowitz and Eyring's incorrect interpretation of the negative temperature coefficient of the oxidation of nitric oxide. After a discussion of quantum effects, again by J. de Boer and R. B. Bird, Part II ends with a chapter which is unusual in a treatment of the kinetic theory of gases; it includes, among other topics, thermodynamics of irreversible processes, sound propagation, flame propagation, and theory of detonations.

Part III is a discussion of intermolecular forces, from the theoretical point of view, though with numerous applications to experimental data. It includes a discussion of electromagnetic phenomena, propagation of light in material media, etc. Not only are the various types and causes of ordinary intermolecular forces considered, but also the forces involved in chemical reactions, though no detailed discussion of chemical binding is given. Intermolecular forces are, of course, involved in Parts I and II, and Part III was designed to give an understanding of them. While we do have a general understanding of intermolecular forces, the calculation of them is generally too involved to be carried out in detail. At the same time, the virial coefficients and transport properties are insensitive to the exact form of the intermolecular potential-energy curve. Some figures are given in the book under review, in which curves for the rare gases, as obtained from various equations, with parameters adjusted to best fit the experimental data, are compared with each other and with theoretical curves. General satisfaction is expressed with the agreement between the various curves, but it may be a matter of opinion as to just how good this agreement should be said to be, and there is no indication as to how great a range of curves might still fit the viscosity data and the virial coefficients.

The book has a number of problems at the end of the chapters, which the authors hoped would be of assistance to students desirous of learning the subject. It is my opinion, however, that the book itself will not be very helpful to such students, since there is a preference almost throughout for formal mathematical procedures rather than the intuitive approach. This is illustrated for example, by the almost complete lack of discussion of the mean free path in the kinetic theory of gases. It is shown also in the discussion of the virial coefficients, where the most general form of cluster integral development is given, and no mention is made of the interpretation of gas imperfections in terms of actual molecular association. To go from one equation to another in the various developments is often a minor research problem. Thus the book will appeal most to people who are actually working on the subjects covered. For such persons it has some very valuable features. It brings together a great diversity of more or less related topics, and summarizes recent researches in these fields. Hirschfelder and his coworkers at the University of Wisconsin have made valuable contributions to many of the subjects treated, and their researches and related researches are discussed, complete with extensive tables of quantities which occur in the calculations. These tabulations should prove very valuable to anyone working along these lines.

In reviewing such a large book it is difficult to make detailed comments. I will confine myself to a few critical remarks on subjects touching on my own researches. In the first place I may say that I do not consider the treatment of critical phenomena to cover properly present day knowledge of the subject. Again, the treatment of communal entropy appears to me to be inadequate and misleading. The communal entropy of a solid cannot be properly understood from a cell theory which arbitrarily excludes it. Finally, if a somewhat personal note may be injected, I may say that I was somewhat surprised to find that my earlier work on intermolecular forces in solid argon was quoted in some detail without adequate discussion of the difficulties involved.