error to the third-year college student has been accomplished.

An entirely new chapter devoted to the experimental techniques of electronics, high vacuum, and glass manipulation has been added to the book. High-vacuum technology is discussed through consideration of types of vacuum pumps and gauges, the detection of leaks, and the basic theory of viscous, slip, and molecular flow. The section on electronics contains an experiment on the determination of characteristic curves of various vacuum tubes, triode amplification, and rectification.

As the authors point out, space for new experiments can be obtained only by the elimination of those from previous editions which have become part of first- or second-year laboratory courses or which, for various reasons, have become less important to the student of physical chemistry. Such casualties from the previous edition of this book include experiments on photoelectric colorimetry, on partial miscibility, on clock reactions, and on unimolecular films and discussions of dimensions and colorimetry.

The second section of the book, dealing with the apparatus and techniques generally encountered in experimental work, has been left unchanged for the most part other than the section on errors mentioned previously. The few new topics cover principally separate discussions of gamma radiation, high-vacuum distillation, and time measurements.

JOHN B. BUTT

Elements of Gasdynamics. H. W. Liepmann and A. Roshko. John Wiley & Sons, New York (1957). 439 pages. $11.00.

Elements of Gasdynamics is an excellent book. The material covered may be ascertained from the chapter headings, which read: (1) "Concepts from Thermodynamics"; (2) "One Dimensional Gasdynamics"; (3) "One Dimensional Wave Motion"; (4) "Waves in Supersonic Flow"; (5) "Flow in Ducts and Wind Tunnels"; (6) "Methods of Measurement"; (7) "The Equations of Frictionless Flow"; (8) "Small-Perturbation Theory"; (9) "Bodies of Revolution: Slender Body Theory"; (10) "The Similarity Rules of High Speed Flow"; (11) "Transonic Flow"; (12) "The Method of Characteristics"; (13) "Effects of Viscosity and Conductivity"; (14) "Concepts from Gas Kinetics." There are very few criticisms which need to be made. It is unfortunate that the authors chose to use the symbols F and G for the Helmholtz and Gibbs free energy rather than A and G. The use of F for the Helmholtz free energy will cause much confusion since most Americans use F for the Gibbs free energy and the majority of the tables of thermodynamic data adhere to this convention. This reviewer would like to have seen a somewhat more extended discussion of the second law of thermodynamics and of the principles of irreversible thermodynamics, especially since the latter is used in one form or another extensively throughout the text. The treatment of the Clausius-Clapeyron equation is very poor and unconvincing. The usual thermodynamic derivations are superior to the quasimolecular one given by the authors. Also, the treatment of imperfect gases is superficial and the relationship

between thermodynamic properties and gas imperfection incomplete. These criticisms are not meant to imply that the thermodynamics chapter is poor, but rather to indicate some places where improvement is possible. The remainder of the book, especially the sections dealing with the hydrodynamics of compressible fluid flow, is admirably clear.

The final chapter on the kinetic theory of gases is short but complements well the rest of the text. This reviewer was very pleased to see a brief discussion of the properties of Couette flow in the Knudsen region. The development of missiles which fly in regions of the upper atmosphere where the mean free path is of the order of the dimensions of the flying object makes this pressure range of great importance.

Elements of Gasdynamics is to be recommended to all students interested in gasdynamics and its applications. The book will also be of interest to physical chemists, who will find a wide realm of irreversible phenomena which awaits exploration.

STUART A. RICE

The Principles of Chemical Equilibrium. K. G. Denbigh. Cambridge University Press, New York (1957). 491 pages. $9.00.

This is a very good book—well planned and well written. While the major portion of the book is concerned with the applications of thermodynamics to equilibrium, as the title implies, the first part is given over to the fundamental principles of thermodynamics. This fine exposition of the first and second laws and of the various thermodynamic functions is distinguished by its thoroughness and clarity.

The second part, "Reaction and Phase Equilibria," is made up of eight chapters. The subjects treated are the properties and reaction equilibria of gases, the phase rule and phase equilibria of pure substances, and solutions. The treatment of fugacity is very good, and it is a pleasure to report that the term *fugacity coefficient* rather than *activity coefficient* is used for the f/P ratio. The discussion of ideal and nonideal solutions is detailed and lucid. It is unfortunate that the most modern manner of tabular presentation of functions with which standard free energies of formation may be computed is not discussed and that equilibrium ratios (K factors), so useful in hydrocarbon phase equilibria, are not mentioned.

The third part, "Thermodynamics in Relation to the Existence of Molecules," consists of five chapters. Statistical analogues of entropy and free energy, partition functions, the third law, adsorption, and chemical kinetics are discussed. While the last may seem somewhat out of place, it is treated only in its relation to chemical equilibrium. A thermodynamic, as distinct from kinetic, derivation of the Langmuir isotherm is presented. There are a number of problems at the end of each chapter (some from Cambridge University examinations), and answers are given with comments in an appendix. The index is reasonably complete. Professor Denbigh is to be congratulated on this excellent work.

HARDING BLISS