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ChE book review

CHEMICAL THERMODYNAMICS: BASIC THEORY AND METHODS, 5th ed.

by Irving M. Klotz, Robert M. Rosenberg

Published by John Wiley and Sons, Inc., NY; 533 pages, \$54.95 (hard cover) (1994)

Reviewed by

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The fifth edition of Klotz and Rosenberg's *Chemical Thermodynamics* is similar in spirit to its four predecessors. It is a text on classical thermodynamics and its applications to mixtures, chemical reactions, and other situations of interest to chemists. It can be used both for undergraduate and graduate instruction and requires no previous knowledge of thermodynamics. The simple mathematical tools needed to understand the material are explained in the book.

The twenty-three chapters cover a wide range of topics. Following two introductory chapters on the history and objectives of classical thermodynamics and on mathematical prolegomena, the First Law and its applications to chemical reactions and to the behavior of gases is discussed. Three chapters are also devoted to the Second Law, its consequences (reversibility, spontaneity, free energy functions) and its application to simple cases of phase equilibria (e.g. the Clapeyron equation, temperature dependence of enthalpies of transition).

Other chapters discuss the Third Law, reaction equilibria, systems of variable composition, gas mixtures, the phase rule, ideal solutions, dilute solutions, activities in non-electrolyte solutions, the calculation of partial molar quantities from experimental data, the determination of activities of non-electrolytes, electrolyte solutions, free energy changes in solutions, gravitational fields, and the estimation of thermodynamic quantities. The fifth edition also contains a new chapter on simple analytical and numerical methods (least squares regression, numerical and graphical differentiation and integration). The above subjects are of obvious interest to chemical engineers, but important topics such as open systems and phase equilibria are not discussed with the depth needed in many engineering applications.

A useful feature of the book is the presence of several examples and problems dealing with biological systems. Specific topics include the calorimetric study of conformational transitions in proteins, free energy and useful work in biological systems, the dissociation of DNA, the solubility of proteins in aqueous solution, osmotic work in biological systems, and protein centrifugation. Several geological examples are also given, especially in the chapter on the phase rule. These biological and geological illustrations, the majority of which can also be found in the fourth edition, add significantly to the book's value and originality.

The book aims at training students in the use of thermodynamics for solving practical problems. This is accomplished very well indeed. Each chapter contains illustrative examples, as well as a good number of problems (typically between ten and twenty). More rigorous and satisfying discussions of the logical structure of thermodynamics are available (e.g., Denbigh's *Principles of Chemical Equilibrium*). In Chapter 3, for example, the authors define adiabatic systems by invoking the notion of thermal equilibrium; however, neither temperature nor equilibrium have been discussed at that point. Similarly, the definition of an ideal gas as one satisfying $PV=RT$ and, in addition, having a temperature-independent energy is redundant. The latter condition follows from the former, but this can only be proved by invoking entropy, which the authors have not defined at that stage (Chapter 5).

On balance, however, the book's virtues outweigh its limitations. Few texts provide the student of chemical thermodynamics with a wider selection of exercises and examples to assist in the development of problem-solving skills. Because of this, Klotz and Rosenberg's book is useful not only for chemists, but also for biologists, engineers, and geologists.

The back cover of the copy of the book that I received from CEE for review, and that of a second copy subsequently sent to me by the publishers, says that this fifth edition contains new chapters on the thermodynamics of the electrochemical cell and on pH diagrams. This is not correct; the book does not include such chapters. I have been assured by the publisher that this matter will be corrected. □