

Books

Molecular Thermodynamics

by Richard E. Dickerson

W. A. Benjamin, Inc., New York. . \$4.95

Reviewed by C. J. Pings

Professor of chemical engineering

Teachers and the planners of curricula are faced with a perennial problem in the modernization of courses in subject areas of rapid change such as science. Not only is there new knowledge to incorporate, but there is need to simultaneously respond to the increasing level of preparation of students as they enter college. Increasing the sophistication of courses is not a matter of great ease. What to leave out or minimize as new material is introduced? When to stop the ad hoc modifications and undertake a total renovation of a course or an entire degree program? The critics of higher education who would have us believe that professors merely rehash the same old lectures year after year might well consider the pedagogic leadership resulting in innovative courses in Caltech's Division of Chemistry and Chemical Engineering during the last decade. Several of these educational experiments have resulted in new-style textbooks, one of which is *Molecular Thermodynamics* by Professor Dickerson. This is one portion of a three-volume set intended to provide the necessary textbooks for a junior-year course in physical chemistry. The other two volumes are *Quantum Mechanics in Chemistry* by Melvin W. Hanna and *Rates and Mechanism of Chemical Reactions* by W. C. Gardiner, Jr. All three volumes are produced by the same publisher.

The reviewer has undertaken only to look at Dickerson's contribution, which proves to be an interesting and an exciting modernization of physical chemistry. The author presents lucid demonstrations of the molecular basis of thermodynamic principles; the reader will also find a convincing structure of macroscopic thermodynamics which could be created on a postulatory basis and applied to real-world problems without recourse to molecular considera-

tions. Dickerson has managed to convey interpretation and understanding without getting in the way of practical application. This is not simply done. For example, through much of Chapter IV, the author carries two symbols for entropy, one for the world of probability of occupancy of various energy states, the other for the macroscopic world of cycles and heat engines. When these two entropies are finally shown to be the same, the equality is plausible to the reader, and at the same time the independent integrity of both the microscopic interpretation and the macroscopic utilization is preserved.

The book treats the three laws of thermodynamics, introduces elementary statistical mechanics, and provides applications through three extensive chapters on phase changes and chemical reactions, solutions, and thermodynamics of living systems. The book is lengthy and contains adequate details of facts and techniques; useful tables of thermodynamic functions are included, and every chapter abounds in provocative problems.

Every scientist has his own taste in thermodynamics, so it is always possible to exalt or be critical with respect to the contents of a new book on this topic. I was particularly pleased to see the stoichiometry and yield of chemical reactions treated with "modern" notation (an elegant formalism introduced by DeDonder in 1920 and only now finding its way into the American thermodynamics books). On the other hand, I was disappointed when I looked in vain in Dickerson's book for a treatment of the virial equation of state for gases; in dealing with the properties of matter, it always seems a pity to expose the chemistry student to the rigorous equations of the perfect gas, which never exists in nature, and to the properties of solutions, which are so hopelessly

complex as to defy molecular level description, yet not discuss the virial equation for dense gases, which is both practical and has a rigorous and elegant derivation in terms of intermolecular forces. Dickerson chooses a sign convention for his work expressions which is the most logical, yet defies the historical trend. With rare lack of clarity he somewhat obscures the expressions relating mechanical work to pressure-volume change; it may be this confusion which eventually leads him into an error in claiming that the expression $dE = TdS - PdV$ applies only to reversible processes.

This is an appropriate text for the modern student of physical chemistry. It could also be read with enjoyment and profit by the former student seeking a fresh viewpoint on how energy level diagrams and partition functions relate to phase diagrams and the operation of distillation columns.

Chemical Principles

by R. E. Dickerson, H. B. Gray,
and G. P. Haight

W. A. Benjamin, Inc., New York . . \$12.95

Reviewed by Fred C. Anson

Professor of analytical chemistry

This is a new textbook intended for use in a first-year course in college chemistry. It has been developed from the 1967 text by Gray and Haight, but it is essentially a new book rather than a revision or new edition. Professor Dickerson has joined the earlier authors to produce a handsome volume which treats most of the standard topics found in conventional freshman texts with a very unconventional flair and style. The discussions are colloquial, engaging, and very easy to read. The deadly pedantry to be found in many freshman texts, and which frequently deludes beginning students into believing that chemistry is intrinsically dull, is refreshingly absent from this book. It seems likely to this reader that freshmen of today will appreciate the obvious efforts that have been expended to get across the important concepts and principles of chemistry by means of language and examples that students will understand and enjoy.

For example, a discussion of energy and metabolism in living systems commences, "To mountaineers who take their hobby seriously, a particularly challenging operation is a 'dynamic traverse.' This is a traverse across a difficult piece of terrain where, at each instant, the climber is in an unstable situation, and where he is prevented from a disastrous fall only by his momentum. In a sense, every living organism is continually engaged in a dynamic traverse. . . . A constant supply of energy is needed from outside sources. . . . If this supply of energy fails, then death and the breakdown of the chemical machine is only a matter of time: a day for the fast-living shrew, a few weeks for man. Just as momentum saves the climber from falling, so a constant influx of energy keeps the living machine from collapsing."

The explanation of entropy includes

a calculation of the Boltzmann entropy of the various possible hands in a poker game as well as the arresting observation that "Boltzmann's equation relating entropy to disorder ($S = k/nW$) is carved on his tombstone in Vienna."

An especially attractive feature of this text is the fact that a series of coordinated supplemental paperback books is available to assist students in studying and learning the subject matter.

"Relevant Problems for Chemical Principles," "Programmed Reviews for Chemical Principles," and "A Study Guide to Chemical Principles" can be selected by each student in whatever combination best suits his needs. The idea is to offer a versatile "Teaching System" which can be adapted to fit introductory courses for students with widely varying backgrounds and preparation in chemistry.

Chemistry is held, in some quarters, to be going out of fashion. Those of us who regard this view as uninformed can take some comfort in the fact that upcoming generations of students who learn their freshman chemistry from Dickerson, Gray, and Haight may well find it hard to put down the always interesting and frequently exciting story of chemistry portrayed in this book.

Richard Dickerson, whose three new books are reviewed on these pages, is a professor of physical chemistry at Caltech. An excerpt, "Why Study Chemistry?", from Chemical Principles, was printed in the January E&S.

The Structure and Action of Proteins

by Richard E. Dickerson and Irving Geis
Harper & Row, New York \$4.95

Reviewed by John H. Richards

Associate professor of organic chemistry

The last two decades have seen a revolution in our understanding of life processes. One great area of progress has been unraveling the mechanism by which hereditary information, written in long molecules of nucleic acid, is passed from one generation to the next and how this genetic information is translated into the potential for action by directing the synthesis of protein molecules which serve as the structural building blocks and catalysts of living organisms.

A second great area of progress has been our learning the precise three-dimensional structures of many of these proteins, structures which have been elucidated by the techniques of X-ray crystallography for the first time in the past decade. This new structural knowledge has provided the necessary foundation for understanding the dynamics of action of these molecules which are at the core of virtually every one of the thousands of chemical processes that together constitute life. Where before, proteins were black boxes—strings of amino acids wound up into obscure blobs—they now stand forth as complex molecules, beautifully constructed, after millions of years of evolutionary trial and error, for their specific tasks: hemoglobin to carry oxygen, chymotrypsin to digest protein in the intestine, serum complement to destroy hostile bacteria.

The Structure and Action of Proteins has combined the talents of an eloquent author with those of a superb artist to tell the story of proteins in five action-packed chapters. The first, "The Rules of the Game," discusses the structures of amino acids and the nature of the amide bond by which these units are joined together in a protein. Two pages, one of text and one of drawings, are devoted to the genetic code. This ratio characterizes much of the book, a part of whose value and lucidity lies in the very beautiful and

Crusade of the Left: The Lincoln Battalion in the Spanish Civil War
by Robert A. Rosenstone
Pegasus, New York \$8.95

Reviewed by John F. Benton
Associate professor of history

informative art work, which complements the excellent text with unusual effectiveness.

Chapter 2, "Bricks and Mortar - The Structural Problems," deals with structural features (β -pleated sheets, α -helices, for example) that characterize the secondary structure of protein molecules. The valuable Ramachandran plot is introduced, and the structures of silk (β -pleated sheet), the α -keratin of wool (α -helix), and collagen are discussed.

Chapter 3, "The Molecular Carriers," considers myoglobin and hemoglobin (the oxygen carriers), and the cytochromes (the electron carriers). It also contains a fascinating section on molecular evolution, one of Dickerson's particular research interests.

Chapter 4, "The Molecular Catalysts," discusses a variety of enzymes. The way in which nature has created three-dimensional structures with catalytic groups optimally disposed is as impressive as any other natural wonder. In at least one situation—the proteolytic enzymes chymotrypsin (from mammals) and subtilisin (from bacteria)—nature has produced, by independent evolutionary pathways, almost identical active sites in different enzymes with otherwise unrelated structures. Though X-ray crystallographers perform a unique service to chemical biology in their structural accomplishments, they are somewhat less authoritative in their mechanistic speculations. As a result, some of the detailed aspects of the mechanisms of enzyme action in this chapter, for example, lysozyme (page 77) and chymotrypsin (page 83) are somewhat unsophisticated.

Chapter 5, "The Next Step Up," begins with a discussion of the nature of "life" and finishes with a five-act drama, including a Sparafucile, on the action of serum complement, meanwhile, having told us about feedback controls on metabolic processes, allosteric enzymes (also discussed in connection with hemoglobin in Chapter 3), and antibodies (gamma globulins).

ONward, sins of Commission, *chaconne à son goût*—Dickerson has a sure hand with the outrageous pun, so outrageous (as in the case of ONward-over-the-bridge) as to be unforgettable, which is, after all, his pedagogical

This exciting and informative book illustrates a generation gap in history, the shift from the viewpoint of contemporaries to those who have no personal recollections of the subject. Participants in the Spanish Civil War, like George Orwell, could write accounts informed with the vividness and perception of immediacy. Robert Rosenstone was born in 1936, the year in which General Franco and his supporters in the church, the army, and the aristocracy began their successful rebellion against the Spanish Republic, and he was only two when the broken remnants of some 3,000 Americans who had gone to the aid of that Republic marched out of Spain, singing the "Internationale."

Rosenstone, who is now an associate professor of history at Caltech, here tells the story of the Americans who went to Spain to fight fascism, most of whom served in the Abraham Lincoln Battalion of the XVth International Brigade. His approach is that of an honest man seeking the answers to hard questions. The Civil War had its roots deep in Spanish history, and on the Republican side it was complicated by the conflicting

purpose.

One of the great virtues of this book is its brevity (120 pages). I have never before seen the potentially complicated subject of protein structure and action treated with such lucidity, beauty, and eloquence.

In addition to the book itself, a set of stereo drawings of many of the proteins discussed is available as a supplement (which also includes a set of—not very good—viewing glasses). I strongly recommend this supplement which provides further inspiring views of nature's feats of molecular construction.

interests of orthodox Communists, Trotskyites, Anarchist-Syndicalists, and other members of the Loyalist coalition. Those who fought in the Lincoln Battalion were not simply aiding the Loyalists, but were also, by desire or not, serving the interests of the Communist Party and the Soviet Union.

For its American participants, what started as a "crusade of the left" became a bloody and sobering war and finally a disorganized defeat which revealed the antagonisms within the Popular Front. Critics were quick to call the Lincolns Communist dupes or worse, and with the aid of the House Un-American Activities Committee a literature was developed to show that wily and brutal political commissars used terror to hold the volunteers to the Communist line. The Communist Party, on the other hand, felt free from the beginning of the conflict to doctor the truth about the Lincolns for its own propaganda purposes, claiming, for example, that the volunteers represented a cross section of the "best elements" in the United States.

In order to write this account, prepared originally as a doctoral dissertation at UCLA (and perhaps it should be said that this is a highly readable book, far from the ordinary dry-as-dust thesis), Rosenstone has combed through a mass of published literature and newspaper stories, and has benefited from such unpublished sources as Alvah Bessie's "Spanish Notebooks" and interviews with some 20 veterans of the Lincoln Battalion. He also visited the sites of the Spanish battles he describes so vividly. This deep familiarity with his material has permitted him to write a satisfying