BOOK REVIEWS

Introduction to Nuclear Engineering. By RAYMOND L. MURRAY, Professor of Physics, North Carolina State College of Agriculture and Engineering. Prentice–Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. 1954. xiii + 418 pp. 15 × 22 cm. Price, $9.35.

This is a textbook in nuclear engineering which discusses a large number of reactor design and application aspects. It provides an elementary treatment of theoretical and practical problems to give the reader a broad view of reactor physics and engineering. In this respect it is certainly a valuable book and can be recommended highly as a concise introduction to the field. It will serve a needed function in the training of engineers for reactor work.

The background of the North Carolina water boiler is quite apparent, although there has been considerable success in incorporating theoretical approaches and problems appropriate to a variety of reactors. To quote the publicity on the jacket, the term nuclear engineering is not only "applied to the nuclear reactor—its design, construction, testing and operation, but also to such related activities as: the accumulation of nuclear fuel and other materials with unusual properties; the handling of radioactive chemicals; the design of instruments for experimental particle detection; establishment of standards and practices in radiation protection; and the use of isotopes for industrial and biological purposes. The technology and problems of the use of atomic energy in all its phases is discussed in detail."

The author uses a very direct approach in his development of the fundamentals of reactor theory. This has unquestionable pedagogical advantages, but although the student may remember reactor equations used in the book, the physical basis may not be understood in numerous cases. To say that many things are over-simplified is not in itself a criticism of the book. However, the student should not draw the conclusion that a reactor design can be determined in perhaps nine pages of text. Co-authorship with someone practicing in the field might open the vista to scan the complexity and challenge inherent in this field. Another over-simplification involves general statements which are applicable, for example, only to thermal reactors, but are made without any limiting qualification.

The only paragraph to which strenuous exception is taken discusses reactor safety practices. "For every safe reactor that is constructed, however, there are dozens of experimental assemblies of fissionable materials, each of which can be called a reactor in the general sense. Because of the transitory nature of these tests, the desire for quick answers, and the laboratory conditions under which they are performed, the chances of a radiation accident are tremendously increased." This comment is certainly contrary to reactor practices. If an addition to the book were to be suggested, it would be that some discussion of reactor safeguard principles and methods of analysis should be included since the choice of a reactor type and its location depend considerably on safety.

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The Infra-red Spectra of Complex Molecules. By L. J. BELLAMY, B.Sc., Ph.D., Principal Scientific Officer, Ministry of Supply. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. 1954. xvii + 323 pp. 15 × 22.5 cm. Price, $7.00.

This is the book several hundred chemists and spectroscopists have been waiting for. Especially in the years since the war, infra-red spectroscopy has been applied more and more generally to qualitative organic analysis and to the characterization of organic substances. There has been a real need for a comprehensive survey of, or at least a good guide to, the useful correlations between particular bands in the infrared spectrum and corresponding functional groups in the molecule. A number of "magic charts" have been published in the past summarizing these correlations; but, as Bellamy points out, "their incautious use can lead to wholly misleading results." And it has been very difficult to find the needed critical discussion of a particular correlation in the widely scattered literature of infrared spectroscopy.

Dr. Bellamy has brought together in this book, as he says, "a critical review of the data on which infrared spectral correlations are based, indicating the classes of compounds which have been studied in each case and the known factors which can influence the frequencies or intensities of the characteristic bands." In the places where we felt competent to judge his discussion, we found his remarks intelligent, informative and constructive, without being dogmatic.

The book is therefore a working reference for the chemist using infrared spectroscopy or the infrared spectroscopist dealing with chemical problems. It is in no sense a text book and no one will learn infrared spectroscopy from this volume. Nothing whatsoever is said about the practical techniques whereby one gets an infrared spectrum, nor is there any mention of structural concepts of molecules, or any clue to the reason why molecular vibrations are active in the infrared region. The omission of experimental descriptions is not particularly serious, since there are in fact several books available which describe the principles of spectroscopy, and indeed particular spectrometers, in considerable detail. However, it does seem to us that an introductory chapter giving some structural picture of molecular vibrations might have been very helpful. It is not difficult to show from such considerations why "group frequencies" exist, and even an elementary introduction to these concepts makes it much easier to understand which correlations are reliable and which are less certain.

We cannot refrain from applauding Dr. Bellamy's stand on the question of wave-numbers or wave-lengths: "the wave-number scale is the only really satisfactory one for correlation work." An ever-increasing number of chemical spectroscopists agree with this conclusion; to quote again, "probably the most powerful argument which can be advanced for the wave-length scale is the fact that it is easier to construct an instrument which is linear on this basis." We hope that chemists will continue to demand spectrometers which are designed for the user's convenience rather than the instrument maker's.

In short, if Dr. Bellamy's book is not an ideal treatment, it is a thoroughly satisfactory answer to a very real need, and we greet it with enthusiasm. Chemists using infrared spectroscopy have frequently received the negative advice to beware of the simple correlation chart; we can now add the positive advice to buy Dr. Bellamy's book and learn what the correlations really mean.

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Physico-Chemical Methods. Volume I and Volume II. By JOSEPH REILLY, M.A. (Cantab. and N.U.I.), D.Sc. (N.U.I.), Sc.D. (Dub.), D.ès.Sc. (Geneva), Professor of Chemistry, National University of Ireland and WILLIAM NORMAN RAE, M.A. (Cantab.), Sc.D. (Dub.), Professor of Chemistry and Physics, Royal College of Surgeons in Ireland. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York, N. Y. 1953. Volume I—xi + 760 pp., Volume II—vii + 800 pp. 16.5 × 25.5 cm. Price, $15.00 per Volume.

This book is the outstanding treatise on the subject of experimental procedures in physical chemistry. The new 5th edition follows closely the tradition of the four earlier editions which have appeared regularly during the past quarter century. The rapid growth of the subject, especially in recent years, makes it difficult to keep the material up to date. The authors claim that numerous changes have been made in the 5th edition. However, these changes appear to consist essentially of the addition of a few new sentences and references at the end of each chapter. In a few instances more drastic revisions have been included.

The reviewer is gratified to read in the preface that, in subsequent editions, more specialized assistance will be obtained for detailed revision of particular sections and chapters. This set of volumes is so interesting and useful, and contains such a wealth of information that one is reluctant to mention any specific points of minor criticism. The section on a "radioactivity room" is written entirely in terms of radium, although a later chapter mentions in detail numerous radioisotopes. The excellent chapter on vitreous silica does not mention silica spring balances. The reviewer is particularly astounded to find in Volume I, page 477, that gas heated thermostats are still described in detail. It is noted that the electron microscope is not mentioned. The section on X-ray analysis is hopelessly out of date, and the subject of electron diffraction is not included. However a paragraph of 7 lines on the subject of neutron diffraction has been added at the end of Chapter VII. A more comprehensive index would make the volumes more useful. Despite these and other minor matters of omission and commission, the reviewer believes that every student of physical chemistry should be familiar with these volumes, and it is strongly recommended that they should be on the shelves of every library. The excessive cost will doubtless deter individual ownership.

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The Kinetic Basis of Molecular Biology. By FRANK H. JOHNSON, Department of Biology, Princeton University, HENRY EYRING, Department of Chemistry and the Graduate School, University of Utah, and MILTON J. POLISSAR, Department of Chemistry, City College of San Francisco and Biomechanics Group, University of California Medical School, San Francisco. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N.Y. 1954. vii + 874 pp. 16 × 23.5 cm. Price, $15.00.

The reviewer's first contact with the subject matter of this book occurred some twenty years ago when, while taking an advanced course in physical chemistry, he first heard of the exciting advances being made by Eyring, Morse, London and others toward reaching the goal of theoretical chemistry: *to predict from first principles the absolute rate of chemical reactions*. At that time both students and staff were particularly stimulated by the success these workers were having in the analysis and estimation of specific reaction rates for such relatively simple processes as the decomposition of gases (HCl, HBr) and the ortho → para hydrogen conversion. Since Farrington Daniels was in charge of the course, inevitably, speculation turned on whether application ever would be made to biological systems. In view of the complexity of such systems, most of us thought not—at least in our lifetime. Yet, in less than a decade, Eyring and Stearn could publish not merely a paper but a *review* on the application of the theory of reaction rates to proteins, and a few years later Johnson, Eyring and their collaborators were furnishing a series of contributions that dealt with absolute reaction rates as applied to such a definite biological process as bioluminescence. Why were we so mistaken in our doubts?

Aside from the operation of what a colleague terms the fourth law of thermodynamics—given two alternatives, one is more likely to choose the false one—it seems that the unexpected application by the authors and others in attacking biological reactions rests on the philosophy of their approach. Since in a sense this philosophy is the *raison d'etre* of this book, it might be informative to consider it as they have phrased it: "In theory at least, all the chemical and physical processes which molecules enter into are now calculable from first principles. Processes in living organisms seem to be no exception. . . . In applying absolute rate theory to specific reactions, using established values for the properties of the reactants, the calculations necessary to predict the rate of even the simplest reactions are extensive and complicated. In biological reactions the rate is ultimately controlled by enzymes and other proteins having such complex structure and high molecular weight that it is not feasible to calculate the absolute rates from first principles. The same theory applies, however, to complicated as well as to simple reactions and can be used to gain a clearer insight into the mechanism of biological processes. In many cases, for example, it is profitable to visualize the biological process in terms of potential energy surfaces. In any case the quantitative variation in rate with such factors as temperature and pressure is to be interpreted on the basis of the modern theory."

To illustrate and document such a point of view is the purpose of this book; to accomplish this, the authors have collected and organized most of the significant studies. In spite of their regret that limitations in space and time did not allow inclusion of separate chapters on such topics as photosynthesis and ionizing radiations (not entirely neglected, however), the result is a voluminous monograph of 762 pages of text (including about 250 illustrations), 84 pages of bibliography (over 1000 references) and 18 pages of subject index. Since it is not practical, even if one were competent, to comment on more than a fraction of the specific items discussed in this volume, consideration of its general organization appears to be more useful.

Of the 14 chapters, the initial one, simply called Introduction, is to me the most valuable and impressive. In the short space of 42 pages the authors have supplied an excellent abstract of the rest of the book. The theory of reaction rates with particular emphasis on the concept of the "activated complex" (intermediate compound, transition state) is developed, and the necessary mathematical aspects briefly indicated. Application of the theory to typical biological processes is then explored. The remainder of the volume is essentially a documentation and extension in depth of the material outlined in this introduction. First, the theory is rigorously defined and details supplied in a series of chapters dealing with thermodynamics (12 pages), classical mechanics (7 pages), quantum mechanics (27 pages), statistical mechanics (13 pages), culminating in the exposition of the calculation of absolute rates (22 pages). These chapters may well prove to be the most attractive feature of the book for the chemist as they present in condensed form some of the more abstruse aspects of chemical theory. They provide a welcome review for those who studied this material some time ago and should be helpful for the present-day student seeking a simplified presentation. The biochemist, and certainly the specialist in other branches of biology, is likely to find this section tough. Dr. Eyring, who, I suppose, is responsible for this material, has done an excellent job of logical presentation of complicated matters, but there are limits to what can be done in this direction. Most biologists would do well to concentrate on the chapter dealing with thermodynamics (as this is the minimum essential) and skip the others, secure in the knowledge that the mathematical and other manipulations necessary for obtaining the final equations have been adequately handled by competent practitioners.

The remaining chapters are devoted to biological applications. Merely to enumerate representative examples will suffice to illustrate the scope of the treatment: bioluminescence; effect of temperature and pressure on enzymes and other proteins; reversible and irreversible protein denaturation; respiratory processes in bacteria; cell division; action of inhibitors on enzyme systems; action of drugs; narcosis; disinfection; diffusion through membranes; and at the end, two stimulating chapters by Pollisar that deal with the physical chemistry of cell irritability, of nerve impulse and of muscle contraction. To single out any of these for special mention would reveal only the bias of the reviewer; obviously, this one would like particularly those dealing with bioluminescence and enzyme theory.

What, then, can be concluded as to the effectiveness of this somewhat awe-inspiring volume? First, it is certainly the definitive work in the field; the authors have been leaders in providing both theory and experiment for its development. Second, a real service has been supplied by collecting together between two covers the diverse contributions that necessarily have appeared in all types of physical and biological journals. Whether this collective effort with its vast expenditure of time and energy will convince the skeptics or reach those hitherto unfamiliar with these developments is not so clear. The reviewer is well aware of the unfairness to both author and publisher of criticizing a book on the grounds that this is not what he would have written had he been the author. These authors evidently wanted an encyclopedic volume, and they have provided it. It probably will be a valuable addition to both chemical and biological libraries and will serve for many years as a useful account of the development of this branch of biophysics and as a reference book for those that need detailed discussion of