react with alcoholic or aqueous sodium or potassium bromide or iodide to give the corresponding bromo- or iodomercuri compounds; with alcoholic potassium cyanide and alcoholic potassium thiocyanate, to give the corresponding cyanomercuri or thiocyanatemercuri compounds. In none of these reactions was it possible with excess of reagent to convert the compounds into mercury-bis derivatives.

4. The 1-chloromercurimethyl-1,2-dihydro-benzofurans react readily with potassium or sodium hydroxide in alcohol to give the corresponding hydroxymercuri compounds and sodium or potassium chloride. The method is apparently general for alkyl mercuric chlorides since methyl mercuric chloride was converted to methylmercuric hydroxide by a similar procedure. The 1-hydroxymercurimethyl-1,2-dihydro-benzofurans react with acids to form the corresponding salts and, in general, show the typical reactions of any of the known hydroxymercuri compounds.
5. The 1-halogen-mercurimethyl-1,2-dihydro-benzofurans react with sodium stannite to give a quantitative yield of the corresponding allylphenol and metallic mercury.
6. The 1-halogen-mercurimethyl-1,2-dihydro-benzofurans react with ammonium sulfide, potassium hydrosulfide or hydrogen sulfide in dil. acid solution to give quantitative yields of the corresponding allylphenols and mercuric sulfide.
7. The 1-halogen-mercurimethyl-1,2-dihydro-benzofurans react with sodium thiosulfate to give 1-sodiumthiosulfate-mercurimethyl-1,2-dihydro-benzofurans which are unstable compounds decomposing readily into mercuric sulfide and the corresponding allylphenol.
8. The 1-halogen-mercurimethyl-1,2-dihydro-benzofurans react with sodium amalgam and alcohol to give the corresponding mercuri-bis compounds.
9. The 1-halogen-mercurimethyl-1,2-dihydro-benzofurans do not react with methyl iodide or acetyl chloride.

URBANA, ILLINOIS

NEW BOOKS

History of Chemistry. By FRANCIS VENABLE, LL.D. D. C. Heath and Company, Boston, New York, Chicago, 1922. vii + 168 pp. 19 × 13 cm. Price, $1.60.

The perusal of this little volume has brought genuine pleasure to the reviewer. The author's profound knowledge of his subject and his long experience as a teacher have enabled him to present the essentials to the earnest student in such a simple and attractive fashion that these essentials will be readily grasped and easily understood.

To teachers, in the exposition of the history of chemistry, this little book will serve as a nucleus about which to develop a more comprehensive course. It is, indeed, a book full of texts, upon any one of which splendid elaborations are readily possible.

The layman also will find in it things he will wish to know regarding the gradual development of the science which, in the process of its upbuilding, has touched him on so many sides.

The first edition of the book appeared in 1894, followed by many more until the present one, which has been entirely re-written and now appears in a new dress, covering the great advances made in the science in the years which have elapsed since it first ventured forth as an American contribution in this interesting field.

EDGAR F. SMITH

Thermodynamics and the Free Energy of Chemical Substances. By GILBERT NEWTON LEWIS, Professor of Chemistry in the University of California, and MERLE RANDALL, Associate Professor of Chemistry in the University of California. McGraw-Hill Book Company, Inc., 370 Seventh Avenue, New York City; 6 and 8 Bouverie Street, E. C. 4, London; 1923. xxiii + 653 pp. Illustrated. 23.5 × 15 cm. Price $5.00.

Thermodynamics, as sciences go, is venerable. The patient labor of a multitude of students and the genius of many great minds have given to it a generality, a simplicity, and a refinement of form which constitute beauty. Although austere in aspect by reason of this very perfection, thermodynamics is none the less a handy tool for daily use, a succinct language and an illuminating philosophy of natural science. As the authors of this book say in their dedication, "The fascination of a growing science lies in the work of the pioneers at the very borderland of the unknown, but to reach this frontier one must pass over well travelled roads; *of these one of the safest and surest is the broad highway of thermodynamics.*" Finally, thermodynamics though venerable is still rapidly growing, and its new advances promise an even wider outlook and greater usefulness.

This treatise by Lewis and Randall succeeds to a remarkable degree in presenting, with elegance and yet with freshness, all these aspects of thermodynamics. It is not a textbook in the ordinary sense of the term. As the authors say, "Our book is designed rather as an introduction to research, and as a guide to anyone who wishes to use thermodynamics in productive work." It is divided into three parts, "of which the first treats of the foundations of thermodynamics, the second deals with the special methods of applying the fundamental principles to chemical problems, and the third is devoted to a systematic consideration of the data of thermodynamic chemistry."

The authors use very little mathematics and, besides, give a clear preliminary exposition of this, so that the non-mathematical reader need have no fears. The authors have made such a sane and illuminating statement on this subject that it is worth quoting in full.

"Mathematics offers a wonderful shorthand for the precise formulation of well standardized ideas. On the other hand, the expressions of mathematics are lacking in humor, which is to say that they are no suitable medium for those finer shades of thought which are often necessary in the exposition of ideas which are on the way towards standardization. . . . . .We have not consciously sacrificed any desirable elements of mathematical rigor. If we have the appearance of doing so, it is because we feel the great need of a visualization of the numerous problems before us, and because this end seems best to be attained by mitigating rather than accentuating the formality of mathematical analysis. It is a dangerous thing to use any kind of mathematical equation unless we keep its meaning before us, and are able to express this meaning without the symbolism which mathematics affords."

This book is the fruition, or culmination of a long series of brilliant researches which Lewis and his students or collaborators have carried out, and which already have been, for the most part, published in THIS JOURNAL. Naturally, therefore, the authors have drawn largely upon these researches for the illustration and elucidation of their theories. Indeed, we can imagine that Europeans, not appreciating this, may feel that their own achievements have been given too scanty recognition; but this should serve as a useful corrective to many French and German treatises which leave the reader with the impression that the science under discussion is an exclusively Gallic or Teutonic one!

To facilitate mastery of the subject by the isolated and independent student, numerous problems, many of a numerical nature, have been introduced. This is excellent pedagogy. I regret that the authors have not given answers to the numerical problems, for it is my experience that the confidence which a student gains from knowing that he has achieved the correct solution of a problem is of very great value.

"Thermodynamics" is a capital book; clear, vigorous, convincing, and interesting. It is alive throughout with scientific curiosity and enthusiasm. It will broaden the insight and heighten the ardor of its readers. It will be a guide and an inspiration.

ARTHUR B. LAMB

Chemistry. The Science of Matter and its Changes. By HIPPOLYTE GRUENER, Professor of Chemistry, Western Reserve University. Harper and Brothers, New York and London, 1922. 384 pages. Illustrated. 20 × 13 cms. Price $3.00.

The publishers' notice says that "this volume is one of a new series which will be devoted to scientific subjects of interest to everyone, treated in a clear and readable manner." The author has succeeded in giving a clear and readable general view of the whole scope of chemistry. The last nine chapters in particular, which deal with such subjects as Geo-Chemistry, the Organic Chemical Industries, Sanitary and Agricultural Chemistry, etc., could be read with profit and would be read with interest by any intelligent non-chemist.

It is a *tour de force* to cover the entire subject of chemistry in a book of this size, and the book suffers, as might be expected, from the omission of important facts and from over-simplification of statement. The discussion of nitrogen fixation is inadequate, the Bucher process is not mentioned, and the diagram which illustrates the Nitrogen Cycle in Nature is not as clear or as complete as others which we have seen. Confronted with the statement (p. 111) that "matter is indestructible, for the atom never changes," one understands the *for* to mean *because* and is tempted to object "Nay, that follows not." Moreover, we question the truth of the premise. The statement (p. 309) that the polariscope "is a physical instrument which gives us a glimpse of the internal structure of the molecule" gives an entirely false notion of the uses of the instrument.

The information in the book has not been assembled in a manner to take best advantage of the psychology of the reader. While the first few chapters deal clearly and in a simple and readable fashion with the nature of chemical changes, with the conduct and structure of matter, with oxygen, hydrogen, and water, they deal with them *ex cathedra* and the reviewer found himself constantly pausing to ask "How do we know this?" "What is the evidence?" And it may fairly be expected that the uninstructed but ready-to-be-interested reader will fail to react cordially to cold information in the absence of the intriguing thinking by which it is deduced. The statement (p. 169) that "antimony is used in alloys to give hardness" and that "its compounds are used to some extent in the match industry and for giving certain qualities to rubber" would be much more interesting, and no more difficult to understand, if the particular alloy were specified and the particular compound for the special purposes. In speaking of platinum, the observation (p. 173) that "many a crucible has been ruined because the operator assumed that platinum was inactive to everything" would have some value if the substances which attack platinum had only been named. One other instance (p. 223): the author speaks of the meaning of the term carbohydrate, carbon and water, and adds that "this composition, however, is only apparent." His failure to mention the sirup and sulfuric acid experiment is another lost opportunity to increase the interest of his account.

The author's effort to treat chemistry in a simple fashion has had the fortunate consequence that the book contains many valuable suggestions for the teacher. His treatment of normal solutions and of the periodic law is excellent. His distinction between aliphatic and aromatic compounds (p. 234) would be of use in the class room—"Paraffin hydrocarbons are little reactive, but the carbon nucleus is rather easily disintegrated. Benzenes are reactive in that they readily form derivatives, but the carbon nucleus is a very stable one, persisting through a great variety of reactions." An ideal is set up by his statement (p. 297) that "it is the work of physical chemistry to acquire the necessary data by careful measurement, and from them to derive the laws and theories by which we weave the whole together."

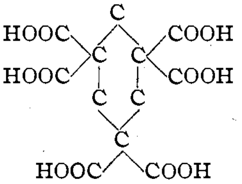
The book is well printed. We have found no typographical errors. The full page pictures are well done and generally represent some technical application of the science. The lack of an index will probably be felt by the reader who is not a chemist. The glossary at the end of the volume contains some excellent definitions, all of them in simple language, and could be studied with advantage by teachers of chemistry. The book will be of interest to educated people who are not chemists, and ought to fill a real want with high school students who wish for something to read beyond their textbook.

TENNEY L. DAVIS

Atomic Form with Special Reference to the Configuration of the Carbon Atom. By EDWARD E. PRICE. Longmans, Green and Company, 39 Paternoster Row, London, E. C. 4; 55 Fifth Avenue, New York; Toronto; Bombay, Calcutta and Madras, 1922. xi + 140 pp. 64 figs. 19 × 12 cm. Price $1.75 net.

This book is a presentation of what the author calls "The Theory of Atomic Form." The assumptions are made at the start (1) that every carbon atom has the shape of a tetrahedron, each face of which is an isosceles triangle whose altitude equals its base, and (2) that two atoms (of carbon or other elements) may be bonded to one another by having a face in common.

A few of the startling conclusions reached by the author, in attempting to make the facts accord with these hypotheses, are the following: that double and triple bonds do not exist; that mellitic acid has the structural formula,



;

that the "methane carbon" in triphenylmethane is attached to but one of the three phenyl groups; that the accepted explanations of the stereoisomerism of such compounds as the malic and tartaric acids are all wrong; and that cyclohexane is a cyclic compound, but cyclopropane, cyclobutane, cyclopentane, cycloheptane, and cyclo-octane are not. Mention is not made of the fact that the theory would necessitate large numbers of isomers which have not been found (such as two isomers of any compound of the general formula H_2CA_2, and three of H_2CAB), nor of the fact that the structures he assumes for the diamond and for graphite are not in agreement with the results of X-ray analysis. Of the facts "explained" by this theory, the reviewer has been able to find none which are not better and more simply accounted for on the basis of the ordinarily accepted ideas.

A model of the benzene nucleus is proposed in which there are 12 exposed faces, 6 above and 6 below the plane of the "Benzenoid." To account for the fact that hydrogens are attached to only 6 of these faces, the author writes:

"It is assumed that the figures of Carbon and its compounds when in the gaseous state are floating in a medium which supports them in much the same way as water supports any objects floating in it, and that the molecules are subject to the same laws of gravity and mutual attractions as are observable in other and larger objects. If it be allowed that the Hydrogen Atom has the form of a very oblate pyramid, it will follow that nascent Hydrogen will adopt a position in which the base of the pyramid will be above and the apex will occupy the lower position.

"In this position the Hydrogen Atoms will readily combine with the lower surface of the Benzenoid, but it will be practically impossible for them to make stable attachments to the upper surface; to do so it would be necessary for the Hydrogen to make a complete inversion of its position so that the base may be below and the apex above, such a change of position would be unlikely. In this view, it would be the *upper* surface of the Benzenoid which would be free from Hydrogen."

The author makes absolutely no use of any of the developments of the past 25 years in the field of atomic and molecular structures.

The book is written in a clear, readable style, and is well illustrated with many diagrams and photographs.

MAURICE L. HUGGINS

Catalysis in Organic Chemistry. By PAUL SABATIER, Dean of the Faculty of Sciences of Toulouse. Translated by E. EMMET REID, Professor of Organic Chemistry, Johns Hopkins University. D. Van Nostrand Company, 8 Warren Street, New York, 1922. xxiv + 406 pp. 23.5 × 15.5 cm. Price $5.00 net.

Dr. Reid purported to translate the 1920 edition of Professor Sabatier's book but gave us a volume that has all of the many good points of the original with several invaluable ones added. The chief worth of the second French edition, which is approximately a half larger than the 1913 edition, lies neither in the theoretical treatment nor in the critical judgment of experimental results, but in the assembling of a great many scattered references and observations on the subject of catalysis in organic chemistry by the man who is preëminent in this field. To list the subjects treated in the book would be but to itemize the fundamental reactions of organic chemistry, since almost all are subject to the influence of catalysts. It was to be expected that more space would be devoted to heterogeneous catalysis and specifically to hydrogenation than to other phases of the subject. One may pick out topics such as the use of copper in the Ullmann reaction which are inadequately treated, but in general the book is well balanced and is a veritable storehouse of facts comparable to Dr. Bancroft's book on Colloids. Dr. Reid has given an excellent translation and has added references to the literature of 1920–22 and many pages of footnotes by himself and others which contain important, interesting, and otherwise unpublished information. These footnotes give a little of that critical examination of the literature which is so greatly needed in the field covered by this book.

The usefulness of the French edition is restricted because it lacks an author or subject index. Dr. Reid at the expense of a great deal of labor has devoted 56 pages to a subject index having some 7000 entries and an author index of 1100 names.

A 2-page sketch of Professor Sabatier's life by the translator and a 12-page article by Dr. Wilder D. Bancroft on "Theories of Contact Catalysis" have been added.

A rapidly widening circle of chemists will find that they owe a great debt of gratitude to Professors Sabatier and Reid for having brought together in a well indexed, convenient, and suggestive form the material contained in this book.

HOMER ADKINS

Organic Chemistry or Chemistry of the Carbon Compounds. By VICTOR VON RICHTER. Edited by Professor R. ANSCHÜTZ and Dr. H. MEERWEIN. Vol. III. Heterocyclic Compounds. Translated from the eleventh German edition, by E. E. FOURNIER D'ALBE, D.Sc. P. Blakiston's Son and Company, 1012 Walnut Street, Philadelphia, 1923. xviii + 326 pp. 22.5 × 15 cm. Price $6.00 net.

With the publication of Volume III (Heterocyclic Compounds) of Victor von Richter's "Organic Chemistry" the complete translation of the eleventh German edition (published in 1913) of this well-known text and reference book is now available. The English translation has appeared in three volumes whereas the German edition appeared in two volumes, the second covering both carbocyclic and heterocyclic compounds. This book is so well known and has been so useful to organic chemists for general reference that it is hardly necessary to mention that Volume III describes the chief compounds and reactions of all except the rarest classes of heterocyclic compounds.

As mentioned in the review of Volume II of the English translation [THIS JOURNAL, **44,** 2067 (1922)], it is regretable that a book which has required so much time and expense in preparation should be 10 years old in subject matter, at its date of appearance. In spite of this fact, all organic chemists will welcome the completed English edition.

ROGER ADAMS

Hexosamines, Their Derivatives, and Mucins and Mucoids. By P. A. LEVENE, M.D. Monograph No. 18. The Rockefeller Institute for Medical Research, New York, 1922. 104 pp. 25 × 17.5 cm.

The monograph is a review of a narrow field of organo-biological chemistry by one of the world's foremost organic chemists who has devoted his time to the organic chemistry of biological products. The purpose of the author as stated in the preface is not to offer a complete review of all the literature on the subject but to bring together that part of it which has appeared from his laboratory in the course of many years.

Of the two sections of his work, the first is devoted to the 2-aminohexoses and their derivatives and was undertaken with the object of procuring data for the purpose of identification of these compounds. The question as to the configuration of carbon atom 2 cannot as yet be answered by direct chemical evidence and, therefore, the use of indirect evidence is justified. The indirect evidence from his own and the work of others is presented. The experimental part consists of experiments on the (1) conversion of hexosaminic acids into their epimers, (2) preparation of hexosaminic acid from 1-aminopentosides, (3) synthesis of hexosamines, (4) 2-5-anhydro-pentoxycaproic acids, (5) 2-5-anhydro-tetroxyadipic acids, (6) chitose and epichitose, and (7) 3-aminoheptonic acids.

Part 2 deals with the mucins and mucoids and in particular with available data and experimental work on chondroitin-sulfuric acid and mucoitin-sulfuric acid, together with a discussion of the distribution of acids of various types in organs and tissues.

W. R. BLOOR

Injury, Recovery and Death, in Relation to Conductivity and Permeability. By W. J. V. OSTERHOUT, Professor of Botany at Harvard University. Monographs on Experimental Biology. J. B. Lippincott Company, Philadelphia and London, 1922. 259 pp. 96 fig. 21 × 14 cm. Price $2.50.

The volume is noteworthy for two things: (a) The quantitative study of rates in the processes occurring in living matter; (b) the development of precision in the definition of such concepts as life, vitality, injury, recovery and death. Due in part to a fortunate choice of experimental material the author has succeeded in studying processes *in vita* which had formerly been known chiefly *in vitro*. The discussion of the problems rests on the assumption that the processes which occur in the organism may be represented by a simple catenary system which obeys the laws of chemical dynamics. The data justify the assumption that life processes consist largely of a series of consecutive unimolecular reactions.

Much of the discussion is based upon changes in permeability of the protoplasm to ions. The permeability is computed from the electrical resistance of the tissues, although other means of determining permeability are also used. Permeability is assumed to be dependent upon the amount of some substance, M, which is formed by the breaking down of a substance, A, and in turn breaks down continually into another substance, B, according to the scheme, $A \longrightarrow M \longrightarrow B$.

The system for marine plants is in equilibrium in sea water; M is renewed as fast as it breaks down. If the velocity of the first reaction be increased, the amount of M will be increased; if the velocity of the second reaction be increased, the amount of M will diminish. When the resistance of the tissue falls to 10% of its original value, death ensues. If tissue be transferred from a toxic solution to sea water before the resistance has fallen too low, recovery occurs, but recovery is incomplete unless the fall of resistance was very slight. The author advances the view that the death process is always occurring, even in an actively growing cell, and produces no untoward effects unless unduly accelerated by an agent which upsets the normal balance and produces such injury that the life process is terminated.

The concepts of all other workers on the nature of cell permeability are regarded as faulty and are discarded. The author assumes that permeability is governed by the amount of a hypothetical combination between various ions and some constituent of the protoplasm. In the case of cells bathed by a solution containing sodium chloride and calcium chloride, the compound is supposed to have the formula, Na_4XCa, in which X represents some constituent of the protoplasm. Further assumptions are made concerning the amounts of Na_4XCa which will be found when cells are immersed in varying proportions of salt and calcium chloride.

Contemporary students of the physico-chemical problems of living matter find no little difficulty in relating Osterhout's assumptions to the principles of physical chemistry on one side, or to biological principles on the other. The discussion is devoted mainly to injury, death and recovery, but is not correlated with the processes upon which the continuance of life depends such as the absorption of water and of solutes from solutions having concentrations comparable to those from which terrestial plants obtain their nutrients. We cannot lightly assume that there is any sharp boundary between these phases of biological dynamics. In view of the relation between the colloidal state and the absorption of water, it would have been advantageous to have had a discussion of their role in determining permeability.

The work constitutes an advance in the analysis of an important problem in biology which workers in that field cannot afford to overlook.

H. S. REED