or aqueous solutions seem to be sufficiently close to this ideal condition to make the measurements in these solvents significant.

4. The introduction of alkyl groups progressively lowers the reduction potential in the case of the 4 alkyl compounds investigated. The introduction of chlorine, on the other hand, first raises and then lowers the potential.

5. In order to measure the reduction potential referred to the solid state of those quinones that form quinhydrones, it was necessary to measure the potential of cells containing quinone-quinhydrone and hydroquinone-quinhydrone. The validity of this procedure has been demonstrated. Data concerning the energy of quinhydrone formation have been thus obtained.

6. The temperature coefficient of the reduction potential referred to the solid state has been measured for all of the quinones investigated and the total energy of reduction thus calculated. A comparison with previous thermochemical measurements shows great discrepancies in the case of the polychloroquinones; the cause for this discrepancy seems to lie in the errors inherent in the thermochemical measurements.

CAMBRIDGE 38, MASSACHUSETTS

NEW BOOKS

A Course of Laboratory Experiments on Physico-chemical Principles. By MILES S. SHERRILL, Associate Professor of Theoretical Chemistry in the Massachusetts Institute of Technology. The Macmillan Co., New York, 1923. x + 125 pp. Illustrated. 22.5 × 14.5 cm. Price $2.00.

The 27 experiments contained in this book are divided into 12 groups of from 1 to 5 experiments, under the following headings: Molecular Weight from Vapor Density; Vapor Pressure and its Lowering by Solutes; Distillation in Relation to Vapor Pressure; Distribution of Solutes between Phases; Freezing-Point Lowering and Molal Composition; Electrolysis, Transference and Conductance; Rate of Chemical Change; The Equilibrium of Chemical Changes at Constant Temperature; Equilibrium of Chemical Systems in Relation to the Phases Present; Heat Effects Attending Chemical Change; Electromotive Force of Cells; Effect of Temperature on Chemical Equilibrium. Each experiment is carefully organized according to a uniform plan, in which the Principles Involved are first listed, followed in order by an Outline, a description of Apparatus, the detailed Procedure, the required Treatment of Results, and a Discussion of the broader aspects of the experiment and the sources of error.

The individual experiments are, in general, good. This is particularly true, for example, of the study of the equilibrium of hydrogen and iodine at high temperatures, and of several of the experiments on electromotive force. The use of conductivity measurements in following the rate of a

reaction illustrates the advantageous combination of the study of method and principle. It is no doubt the intention that a number of the experiments be used as alternates. The performance of both experiments on vapor density, for example, would disproportionately emphasize this portion of the work. Similarly, it is a question whether experiments on distribution are sufficiently representative or important to justify their utilization in three different assignments. In one case, the endeavor to keep experiments simple and apparatus robust has been carried too far. The experiment on electrolytic conductance, in which the effect is measured of varying the length, concentration, etc., of copper sulfate solution between copper plates in a wooden trough, seems of doubtful value for a student of average intelligence.

In criticizing the book from a more general standpoint it is necessary to bear in mind the author's single intention of emphasizing principles (to large classes with little time). The reviewer is one of those who believe that arrangements as to time and facilities should be made to permit some emphasis of two other important features: (1) the stimulation of the initiative and resourcefulness of the better students in their experimental work, and (2) the study of standard methods, *per se*, with apparatus good enough to give the feeling that real tools are being used. The work of the present manual consists mainly of set exercises, rather than experiments in the planning or adaptation of which the student takes increasing part as the work progresses. By its sustained carefulness and completeness in this regard, it may fail to assist the instructor in achieving the first of the above objects, and the second of them has been deliberately subordinated. Having made his choice, however, Professor Sherrill has accomplished his purpose with undoubted success.

E. D. EASTMAN

Principles of Chemical Engineering. By WILLIAM H. WALKER, WARREN K. LEWIS and WILLIAM H. MCADAMS, Professors of Chemical Engineering at the Massachusetts Institute of Technology. McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York; London, 6 and 8 Bouverie Street, E. C. 4; 1923. ix + 637 pp. 156 figs. 23.5 × 15 cm. Price $5.00.

This book follows the general scheme of dividing industrial chemical processes into a number of basic or "unit" processes, such as flow of heat, distillation, combustion, drying, flow of fluids, etc., and then treating each one of these fundamental operations from a general standpoint without reference to any complete manufacturing process. The underlying, scientific principles are first discussed, then these principles are utilized to explain the phenomena involved and, wherever possible, to develop equations that enable one to predict the result of a change in conditions or to design a piece of equipment for a specified duty. In nearly all cases the use of the equations is well illustrated by the solution of typical prob-

lems founded, for the most part, upon data obtained from actual tests on operating equipment or from undergraduate theses.

The foundation for the quantitative treatment which is accorded to nearly all of the subjects discussed, is well laid in the first chapter, which is devoted to a general exposition of the methods of making industrial calculations. This chapter contains nothing essentially new, but condenses into small space an excellent review of many fundamental laws and clearly shows how they can be pressed into the engineer's service. The quantitative treatment of each subject is usually accompanied by a brief description of the most important standard types of equipment available for commercial use. The limitations and advantages of each are discussed in the light of the general principles previously considered. Notable exceptions to this occur in the cases of "Flow of Heat" and "Flow of Fluids," especially the latter, where one expects some description of fans, pumps, air lifts, etc.

Many of the subjects, such as the flow of heat, combustion, gas, producers, etc., have for some years been included in many of the standard textbooks on mechanical engineering and hydraulics, but from a wholly different viewpoint. For example, in the case of "Flow of Fluids," the quantitative treatment has been generalized. In this book it applies not merely to steam, air and water under the special conditions usually encountered in engineering practice, but to the much greater variety of fluids under many different conditions of pressure and temperature with which the chemical engineer has to deal. Likewise, such subjects as combustion and gas producers are treated from a much more chemical point of view. It is obvious to chemists that the use of molar quantities would introduce considerable simplification.

From the amount of space devoted to filter calculations one is led to believe that commercial filtration has been largely reduced to a mathematical basis. Careful study of the development of the formulas reveals that the general equations are, to a large extent, based on assumptions for the validity of which no experimental evidence is adduced. Furthermore, there are so many variables involved in filtration that the constants in the equations are really functions of a number of complex variables and as a result their usefulness is greatly limited. The same criticism applies to the chapter on "Drying," more than $^2/_3$ of which fairly bristles with equations for the design of all kinds of driers under every possible condition. These equations are developed from a few fundamental differential equations involving assumptions as to the mechanism of drying which are not supported by any direct experimental evidence. A few of the final equations are tested on the data obtained from undergraduate theses with satisfactory agreement, but such a test merely serves to show that the equations are satisfactory for the purpose of interpolation under the given conditions.

There is no question as to the desirability of eventually placing all the subject matter of chemical engineering on a mathematical basis, but if this is to be stable it must rest on well-tested principles. This is possible in many cases at the present time, but in others it seems to the reviewer to be decidedly premature.

Chemical engineering covers a rather broad field and naturally the authors have been obliged to limit themselves to a few of the most important subjects. Many chemists and chemical engineers will probably disapprove of the prominence given some subjects, of the scant attention received by others (notably fuels and power) and of the complete omission of many important subjects, such as corrosion, plant control methods, mixing, etc. However, these are points on which no two persons could agree and, on the whole, it may be said that the authors have made a wise selection.

Since it is practically the pioneer in its field this book should receive an enthusiastic welcome from all those who are interested in the application of chemistry (one almost feels constrained to say physics, because the majority of the underlying principles belong more properly in the domain of physics than in that of chemistry) to industry and particularly from those who are concerned with instruction in industrial chemistry and chemical engineering. This is the purpose for which it is primarily intended and it has already proved its worth through having served an extensive apprenticeship as a text, in the form of notes, not only at the Massachusetts Institute of Technology but at several other institutions as well.

One may not agree with all the mathematics, with the arrangement or relative importance given to the various subjects, but one is certainly impressed with the vast amount of quantitative information presented and particularly with the ingenious ways in which well-known scientific principles are applied to the solution of industrial problems.

BARNETT F. DODGE

Lehrbuch der Cellulosechemie (Textbook of Cellulose Chemistry). By DR. EMIL HEUSER, Professor of Cellulose Chemistry at the Technical School, Darmstadt. Second edition. Gebrüder Borntraeger, Berlin, 1923. vii + 211 pp. 3 figs. 24.5 × 16 cm. Price $1.55.

The second edition of this very suggestive and useful monograph, while it includes references to articles on cellulose that have appeared since 1920, shows no great change or development in the author's point of view. The book has been written and rewritten primarily from the standpoint of the organic chemist to whom cellulose is a special type of polyacid alcohol—a specific polysaccharide which is always the same chemical compound no matter what its botanical source. Thus we find the cellulose alcoholates, esters, ethers, as well as oxidation and hydrolysis products of cellulose

discussed from the standpoint of the research chemist as well as that of the technologist with a consistent clarity of expression that merits the highest praise. The circumlocution, which for the past 30 years has haunted monographs on cellulose, and those hopeless labyrinths of detail that demoralized investigators, have disappeared. On the other hand, the interests of the physical chemist and the needs of the technologist who is daily brought into contact with the colloid chemistry of cellulose have been subordinated and at times completely neglected. While the author has done this quite deliberately, realizing the many loose ends that he would encounter in this field, the reviewer regrets that this important phase of cellulose chemistry plays such a minor role in his useful book. Nor does the author always give both sides of a mooted question. As a single example, the work of the physical chemist, Leighton, which argues against compound formation when cellulose is brought into contact with alkali, has received no mention in Heuser's first chapter, whereas the recent (though perhaps less critical) work of the organic chemist, Karrer, which favors the hypothesis of compound formation is duly cited. Hibbert's important critical review of the literature on cellulose, and his subsequent formulation of the constitution of cellulose have not been adequately mentioned and the classical quantitative researches of Irvine and his colleagues at St. Andrews have not been given the place they deserve in Heuser's chapter on "Constitution of Cellulose." In spite of these obvious errors of omission, Heuser's little volume is invaluable to the chemist interested in carbohydrates and to technologists in the many industries in which cellulose serves as a raw material.

LOUIS E. WISE

An Introduction to the Chemistry of Plant Products. Vol. II. Metabolic Processes. By PAUL HAAS, D. Sc., Ph.D., University of London, and T. G. HILL, University of London. Longmans, Green and Company, 55 Fifth Avenue, New York; 39 Paternoster Row, London, E. C. 4; Toronto; Bombay, Calcutta and Madras; 1922. viii + 140 pp. 11 figs. 14.5 × 22.5 cm. Price $2.50 net.

In the third edition of the work under notice the material previously included in one volume has been divided into two parts in order, as has been stated by the authors, to give the more purely physiological aspect of the subject fuller treatment. While, therefore, the first volume is now chiefly restricted to a description of some of the principal chemical constituents of plants, the second one deals more specifically with metabolic processes. The subject matter of the present volume is divided into 6 chapters, which are given the following titles: I. Introduction: The Living Plant; II. The Synthesis of Fats; III. The Synthesis of Carbohydrates; IV. The Synthesis of Proteins; V. Respiration; VI. Growth (including a brief consideration of auximones, hormones and vitamins).

Although the changes which take place in living plants were formerly

considered to lie chiefly within the domain of vegetable physiology, and therefore to be more especially of interest to the botanist, it is evident that these metabolic processes are now also actively engaging the attention of the chemist, for it is only by the application of chemical and physical methods that further knowledge can be obtained respecting vital phenomena and their biological significance. It is well known, as the authors have noted, that more than 50 years ago Baeyer formulated the hypothesis that carbon dioxide is split up by the plant into carbon monoxide and oxygen, and that the water is concurrently resolved into its constituent elements. It was further assumed that the carbon monoxide and hydrogen thus produced then combine to yield formaldehyde, which undergoes polymerization and so forms a hexose. These chemical changes which were thus presumed to be comparatively simple have, however, in the meantime been the subject of considerable discussion, with some attending modification of the original views, and for the elucidation of photosynthesis in its fundamental as well as in its broader aspects the most refined methods of chemical investigation have now been brought into requisition. It is to be expected that problems so recondite in character should be attended with many statements which as yet must be regarded as more or less hypothetical or speculative, and also that errors of observation may occur. As an example of the divergence of views respecting the chemical changes effected in biological processes it may be sufficient to call attention to the results obtained by an American investigator[1] who has been unable to confirm the statements concerning the reduction of aqueous carbon dioxide to formaldehyde by the action of ultraviolet light and the subsequent polymerization of the aldehyde to hexose sugars.

The work under present consideration is one which will be perused with interest by both chemists and botanists and, although aiming only to present such an account of the various processes and products of plant life as to form a basis for further study, it contains much information of immediate usefulness respecting the existing state of knowledge. The book is well printed and is provided with a very complete index.

F. B. POWER

Clinical Laboratory Methods. By RUSSELL LANDRAM HADEN, M.D., Associate Professor of Medicine, University of Kansas, School of Medicine, Kansas City, Kansas. C. V. Mosby Company, St. Louis, Missouri, 1923. 294 pp. 69 figs. and 5 plates. 23.5 × 15.5 cm. Price $3.75.

Modern diagnostic laboratories are constantly called upon to carry out a considerable variety of procedures. Some of them are in the nature of chemical analyses, both qualitative and quantitative, some are bacteriological, some cytological, and some serological.

[1] Spoehr, THIS JOURNAL, **45**, 1184 (1923).

This book is the equivalent of such note books as are compiled in many laboratories for the benefit of the different workers. No attempt has been made to discuss the procedures or to give alternate methods, beyond indicating the value for each determination found on the average normal subject, or to discuss the interpretation of the results; as the author states in the preface, the book is not a textbook. The reviewer would like to point out that such a book will not enable a chemist to undertake clinical pathological tests, nor will it enable the worker trained in bacteriology and the technique of blood counting to carry out successfully quantitative analyses on blood and urine. The first group of workers would, for instance find difficulty in identifying intestinal protozoa from the charts and tables given, and the clinical pathological worker would almost certainly get into difficulties through ignorance of some of the precautions necessary for insuring purity of reagents, standard solutions, etc., in spite of the precautions described in the twelfth chapter, should he try to carry through chemical analyses.

In the province which the book is intended to cover it is successful. The examinations chosen for presentation are such as are at present of most use in studying patients. None is described that does not have a rather wide application, and few have been omitted that have been proved to have any extensive clinical application. The book, therefore, should be useful for any laboratory as a help in measuring the value of the service which it is prepared to render to the clinician. Whether the methods—particularly the chemical methods described—are those best adapted to each procedure, is a question on which different workers will markedly differ. As was stated in a review of Dr. Haden's book in the British Medical Journal, chemical methods in use are changing so rapidly that probably none of the procedures in use today will continue to be followed 10 years from now; criticism of individual methods is, therefore, of comparatively little value.

It seems to the reviewer that this book will serve very well as the basis for a useful handbook for any clinical pathological laboratory. The successful laboratory will almost inevitably change some of the procedures, omit some and add others; nevertheless, the publication of such a work, if the limitations implied by the statements in the preface are kept in mind, will prove of great value to hospital and commercial clinical pathological laboratories.

ROGER S. HUBBARD