radical from the β- to the α-position takes place, giving as final product an α-glycerol ester.

5. The data submitted provide further convincing evidence as to the unreliability of deductions relating to the structure of glycerol, carbohydrates and polysaccharides based on conclusions drawn from experiments on the hydrolysis of their acyl derivatives.

MONTREAL, CANADA

NEW BOOKS

The Origins and the Growth of Chemical Science. BY J. E. MARSH, M.A., F.R.S., Fellow of Merton College. John Murray, 50A Albemarle Street, London, W. 1, England, 1929. x + 161 pp. Illustrated. 12.5 × 19 cm. Price, 5 shillings, net.

The history of chemistry, from the point of view of the author of this small but compact and well-filled book, is not a mere record of events. The events must be interpreted, correlated, put in order—for history itself is also a science and its data, however interesting they may be in themselves as data, still submit to a scientific treatment. Marsh interprets the history of chemistry as the history of two principal ideas—of the idea of salt formation, first clearly articulate with Boyle and even now presenting problems and influencing research, and of the idea of the fixation of gases, with the early work on which the names of Black, Priestley, Cavendish, Scheele and Lavoisier are associated.

In his preface Marsh says that "there was no science of Chemistry before the seventeenth century, but the art of Chemistry had progressed through long ages," etc. His first chapter is devoted to the "fire theories" of the ancient philosophers and of the alchemists and phlogistonists. Now it seems to the reviewer that, where we have theories, there we have data interpreted—and have science. Primitive chemical theories were chemical theories after all, not wilfully fantastic perversions of thought. We wish to know how they came to be and the reasons which led to their abandonment. Marsh points out that the phlogiston doctrine, which was the last stand of the ancient fire theory, was put forward in 1702 but "did not attract much attention from chemists in Stahl's lifetime or for some forty years after his death in 1734. The theory was then taken up by Priestley, by Scheele and by Cavendish, to explain the nature of the gases which they discovered." But the quantitative phenomena connected with the fixation of gases showed its inadequacy and created the necessity for the interpretations of Lavoisier.

The book contains a number of things such, for example, as the mention of Higgins's suggestions in 1789 relative to multiple proportions, which show that the author has a scholarly knowledge of his subject. One chapter details briefly the essential facts about the discovery of each of the known elements. The index is excellent and the names of men are generally followed by dates and often by a mention of a biography. Students will find that the book arouses their interest in the history of chemistry. Those who are already familiar with the subject will find it refreshingly different and will perhaps question, as the reviewer has done, whether the text has not determined the argument, whether the motives which run through the unfolding drama of chemistry are not more involved and far more numerous than Marsh's book would lead one to think. Yet Marsh has made an excellent study of two of these motives.

TENNEY L. DAVIS

Chemisches Fachwörterbuch für wissenschaft Technik, Industrie und Handel. (Chemical Dictionary for Science, Industry and Business.) Edited by A. W. MAYER. Otto Spamer, Leipzig, Germany, 1929. Vol. I. German–English–French. 826 pp. Price, unbound, M. 70; bound, M. 75.

A review of so complete and voluminous a work as this can cover little more than a certification of its extent, the evident care and efficiency of its production and the very complete field it covers. Prepared by one who has had special experience in translating, it really does cover more than a mere list of German technical words with their English and French equivalents, but while serving as a very complete scientific chemical dictionary, it "simultaneously introduces practical examples of the chemical and chemico-technical phraseology customary for the several industries in the three principal languages" and gives "special consideration to the requirements of trade and of the industrial and technical expert by giving appropriate equivalents, in the languages concerned, for the special professional terms and phrases for manufacturing processes, special machinery, apparatus, etc." The second volume which is to follow will be in English–French–German, and the third in French–German–English. Those who are fortunate enough to have this volume in their libraries should have no difficulty in obtaining the correct English or French equivalent for almost any German word or technical phrase.

CHARLES L. PARSONS

A Comprehensive Treatise on Inorganic and Theoretical Chemistry. Vol. IX. Arsenic, Antimony, Bismuth, Vanadium, Columbium and Tantalum. By J. W. MELLOR, D.Sc. Longmans, Green and Company, 55 Fifth Avenue, New York; 1929. xiv + 969 pp. 113 figs. 25 × 16 cm. Price, $20.00.

The publication of this valuable handbook is progressing with commendable rapidity. The present volume exhibits the same treatment and embodies the same excellent qualities as the earlier volumes. Here as before the author has succeeded in making at once succinct and readable what is essentially and unavoidably an encyclopedia.

ARTHUR B. LAMB

Volumetric Analysis. Volume I. The Theoretical Principles of Volumetric Analysis. By Dr. I. M. Kolthoff, Professor of Analytical Chemistry, University of Minnesota, with the collaboration of Dr. Ing. H. Menzel, Dresden, Germany. Translated from the German by N. Howell Furman, Associate Professor of Analytical Chemistry, Princeton University. John Wiley and Sons, Inc., New York, 1928. xvii + 289 pp. 20 figs. 15.5 × 23.5 cm. Price, $3.00.

Ostwald, in 1894, wrote an interesting little book showing some applications of physical chemistry to analytical chemistry and his ideas have been carried farther by Böttger, A. A. Noyes, Stieglitz, W. M. Clark, Erich Müller, Kolthoff and others. In fact, most teachers of analytical chemistry now believe that it is more important to stress the underlying theories rather than the laboratory procedure and have found that students actually do better work in the laboratory when they understand what they are doing rather than follow procedures blindly. The purpose of this new book by Kolthoff is to explain the reactions of analytical chemistry in terms of the mass-action law. From this principle it is possible to predict whether a reaction is suitable for quantitative work, to calculate the titration error on the assumption that the observations are correct and to determine the ideal conditions for carrying out an analysis. The book, therefore, is a welcome addition to the literature of analytical chemistry.

There is probably no one living today who has contributed so much to the scientific study of volumetric analysis; Kolthoff publishes about twenty-five papers a year, all of them having merit. A considerable part of this book has, therefore, been published already in his scientific papers. It is well to have the subject matter collected and published again.

It is undeniably wrong to teach chemical theory entirely apart from chemical practice and it is far better to teach physical chemistry to Freshmen and to Sophomores than to wait till the Junior or Senior year before attempting to discuss in detail the theories underlying all chemical work. Theory helps one to remember and correlate facts and the Freshman who is ready to study calculus is able to understand the mathematics of science and he has greater respect for both mathematics and science when the relationships are shown early in his career.

There is no mathematical equation given in this book but what is easily understandable by the average college student and there is little, if anything, that ought not to be taught to beginners in analytical chemistry. Equations, such as that of Nernst for showing the relation of electrolyte concentration to electrode potential, and which are derived with the aid of integral calculus, are not explained at all but the student is asked to take them for granted.

On the other hand, it is well known to teachers of chemistry that college students often have considerable difficulty in applying simple arithmetical principles to chemical reasoning and so it is necessary, in order to accomplish the best results, to introduce mathematical equations cautiously at first and with considerable explanation, seemingly unnecessary to the mathematical expert. In this way, Stieglitz and Clark have written books which are instructive and based on mathematical reasoning but are at the same time intensely interesting. The book under review was not written with this idea in mind; it will be read and understood easily only by one who is thoroughly conversant with the mathematical nomenclature of physical chemistry. Thus on page 245, the usual method of expressing concentrations in volumetric analysis is discussed at some length (something that every student of analytical chemistry is taught at the start) but throughout the preceding pages of the book concentrations are invariably expressed in moles per liter without any comment because this is something that every student of physical chemistry is supposed to know.

Chapter I is particularly difficult for the beginner; 107 numbered equations are given in 42 pages of text. This makes hard reading and unless one is familiar with the conventional terms of physical chemistry it is difficult to see exactly what some of the unexplained equations really mean. Thus on page 2, the idea of Sörensen's "ion exponent" is introduced and thereafter low concentrations are usually expressed in terms of negative logarithms. So instead of saying that the solubility product, S, of calcium carbonate is 1.2×10^{-8}, the expression $p_S = 7.92$ is advocated. This is all very well but it would almost seem as if more explanation should be given. To illustrate the extent to which the mathematical development has gone, it may be mentioned that pages 31 and 32 are devoted to the calculation of the extent to which calcium carbonate is hydrolyzed in pure water on the basis of the ionization constant of water and the secondary ionization constant of carbonic acid. This involves the solving of a cubic equation. Unfortunately, Kolthoff has used here a value for the ionization of carbonic acid which is ten times as large as the value he gives on page 276 and which is presumably correct.

The work of the translater is well done; the English is good and the meaning is clear, although at times the translation is a little too literal.

Without going into further details, the reviewer wishes to emphasize the fact that this is a good book and well worthy of publication. It is to be hoped, however, that both Kolthoff and Furman will try the experiment of teaching this sort of thing to beginners and then after a few years they will amplify and modify the book so that it will be easier reading.

WILLIAM T. HALL

Messen und Wägen, ein Lehr- und Handbuch insbesondere für Chemiker. (Measurement and Weighing. A Text and Handbook Especially for Chemists.) By Dr. WALTER BLOCK. Otto Spamer, Heinrichstrasse 9, Leipzig, Germany, 1928. viii + 339 pp. 109 figs. 17.5 × 25 cm. Price, unbound, R. M. 25; bound, R. M. 28.

In this volume the author carries out a project originally planned by Dr. Fritz Plato, director of the Reichsanstalt für Mass- und Gewicht, who has supplied the first section. This section (48 pages) deals with historical notes, with the units and fundamental standards of the metric system, with the British Imperial units and with the differences between these and the "customary" units of the United States. This is followed by valuable notes on the care and handling of standards, and on the various standard temperatures in use.

The second section (32 pages) discusses the number of figures to retain in computations, the computation of "mean error" and of "probable error," the distribution of errors among the various measurements of a determination and simple approximation formulas for small correction and reduction factors. Nearly five pages are devoted to slide rules, computing machines, monographic charts and tables used in computation.

In the third section (13 pages), are given what may best be called explanations of the fundamental units of mass, length, time, force, work, energy and pressure, with the standard value of gravity; then short definitions, with dimensional equations, of the units of the c. g. s. system, and a discussion of the most important physical constants—chiefly those of interest to the chemist.

The remaining three-fourths of the book deals directly with the various kinds of measurements, divided as follows: Time, 6 pages; Angle, 7 pages; Length, 25 pages; Surface, 4 pages; Volume and Capacity, 28 pages; Weighing, 22 pages; Density, 37 pages; Pressure, 14 pages; Humidity, 3 pages; Temperature, 29 pages; Heat (quantity), 7 pages; Photometry, 5 pages; Optics (refraction, interference, polarimetry), 14 pages; and Electrical Measurements, 38 pages.

There is also a classified list of over 200 references. In such a list it seems strange to miss the International Critical Tables. It also seems strange to find the Technological and the Scientific Papers of the Bureau of Standards classed as magazines devoted chiefly to methods of measurement.

An outstanding feature of the book is the careful explanation of principles involved. These give usable concepts rather than mere definitions or facts, and many items that tend to a broader culture than is likely to be gained from many mere "reference books."

A number of omissions are no doubt debatable, but some seem strange. For example, neither the Michaelson nor the Abbé-Fizeau interferometers are mentioned in connection with interference measurements; also the dew point instrument is not mentioned, nor are any methods of controlling humidity given.

On page 150 the emphasis on "relative" weighing, as opposed to finding values in correct units of mass, seems very unfortunate.

In the section on humidity, the author speaks of the amount of water vapor that *the air can take up,* thus continuing the old error. Later, a hair hygrometer is said to be checked by checking the saturation point, with no mention of any need for checking some other point also. Neither is there any mention of the fact that checking the 100% point is likely to cause serious changes in reading for many days in the future.

The discussion of standard weights on pages 150 to 152 is greatly complicated, for American readers especially, by the inclusion of ordinary commercial standards. "Präzisionsgewichte," for which tolerances are given, are not laboratory weights. In fact there are *no* German tolerances for laboratory weights.

On page 44, and again on page 151, it is stated that quartz weights are not suitable for precise standards because of the variable moisture film on the surface. Yet researches on adsorption show quartz to have as little as or less than the amount on highly polished metal.

In a book covering so wide a range of topics and such a large amount of detail, one can hardly avoid overlooking many points worth mentioning; and in the present case the reviewer must admit having given scant attention to the sections on electricity and heat, particularly. Neither was any special attention given to checking the accuracy of details, but the examples above show that caution must be exercised in using the book.

A. T. PIENKOWSKY

The Determination of Hydrogen Ions. By WILLIAM MANSFIELD CLARK, Ph.D., Professor of Physiological Chemistry, The Johns Hopkins University. Third edition. The Williams and Wilkins Company, Baltimore, 1928. xvi + 717 pp. 100 figs., 1 plate. 15.5 × 23.5 cm. Price, $6.50.

Clark's book since the appearance of its first edition in 1920 has been the standard on its subject. The new edition brings it abreast of the moment in its rapidly developing field. There are several entirely new chapters. New techniques are described, including the application of spectroscopy and colorimetry, and of metallic oxide, glass and oxygen electrodes. The theoretical treatment is broadened by chapters on the theory of titration, on changes of free energy and on the Debye-Hückel extension of Arrhenius' dissociation theory. Many chapters represented in the previous edition have been so completely revised that they constitute largely new material. The chapter on oxidation–reduction potentials has been nearly doubled to include new developments of the field, due in no small part to Clark's own investigations. The author has adhered to a style as condensed as is consistent with clarity. The precise choice of words gives continual satisfaction. The expansion of the entire book from the 480 pages in the second edition has been forced, despite the condensed form, by the new material demanding presentation. The printer's work is well done.

DONALD D. VAN SLYKE

Molecular Rearrangements. By C. W. Porter, Professor of Chemistry, University of California. The Chemical Catalog Co., New York City, 1928. 167 pp. 16 × 23.5 cm. Price, $4.00.

The subject of molecular rearrangements is the family skeleton in the organic chemist's closet. Everyone knows that rearrangements occur but one is rather loath to talk about them. If they were the rule rather than the exception, organic chemistry would be a nightmare. As it is, the possibility of a molecular rearrangement haunts every series of transformations and all the pretty "proofs of structure" exhibited to our students should be followed not by the letters Q.E.D. but by B.M.R. (barring molecular rearrangements).

The appearance of Professor Porter's monograph will undoubtably serve to direct the attention of students and teachers to the subject of molecular rearrangements. It is now possible, for the first time, to refer an advanced student to a book dealing with the subject. The bibliography will be of value to investigators who wish to become oriented in regard to the published work on any particular type of rearrangement. The book makes no pretense of being a complete summary of the subject. This choice of a limited amount of material makes it a more readable book than would otherwise be the case and probably many who are not organic chemists will peruse it with interest and enjoyment.

The first four chapters deal with carbon to nitrogen, nitrogen to carbon, carbon to carbon and oxygen to carbon rearrangements. A special chapter is devoted to migrations between oxygen, nitrogen and sulfur, and the two final chapters deal with metatheses and certain reversible processes. There is an interesting preface giving one a glimpse of the author's point of view in regard to the much-debated subject of the mechanism of rearrangements. In this connection it seems strange that there is no discussion in the book of Meerwein's work on the mechanism of the Wagner rearrangement. This work seems to the reviewer to be one of the outstanding developments in the last ten years and to provide the experimental basis for a discussion of the mechanism of a large class of rearrangements.

James B. Conant

Organic Chemistry. A Brief Introductory Course. By James Bryant Conant, Professor of Chemistry, Harvard University. The Macmillan Company, New York, 1928. ix + 291 pp. 30 figs. 14.5 × 22 cm. Price, $2.65.

This is an excellent book, designed for the shorter courses in organic chemistry. There is no text of its size which equals it, in the opinion of the reviewer. In fact, many larger books could be cited which fail to present an equally adequate idea of organic chemistry, its relations to other disciplines and to industry. In his preface, the author states that the book was planned to arouse an interest in the subject, as the first necessity in teaching it. On the testimony of students, the book *is* interesting—on the testimony of the reviewer, it is interesting, even after much reading of organic texts.

There are several points about the book which are worth some amount of discussion. Probably the most important one is the radical departure from the time-honored start-off with the saturated hydrocarbons. Whether this is an advantage or not is difficult to decide, since it is impossible to apply the experimental method! In the reviewer's opinion, there is a loss to be faced, in starting with the alcohols, which is not counterbalanced by the facility with which the student's interest may be seized, or the ready material for treating isomerism for the first time. With regard to the latter point, it must be admitted that it is easier to see differences in the formulas with an O in them, than in those containing only C's and H's. At any rate, the first chapter is most deftly handled, and will repay study by all who are interested in teaching organic chemistry, regardless of their predilections.

Another minor issue to be joined, is the amount of space which should be granted to the benzenoid–quinoid relationships, even in a text of this size. One is rather led to suspect that Dr. Conant has unduly limited himself in this discussion, through a desire to avoid over-emphasis of a field in which he is so effectively interested.

Perhaps it is time to mention the two points which have most impressed the reviewer. The first is the very great amount of information which has been compressed into a small compass, without any perceptible slackening of the even flow of the author's notable style. The book will require study, but it will be easy to study. The second point is the nice degree of emphasis which has been placed on industrial processes. Most texts, even much larger ones, leave much to be desired in this respect, either through the inadequacy of the space assigned to industrial processes, or through lack of up-to-dateness. It is certain that the latter fault does not appear here, in the cases of which the reviewer has personal knowledge.

All in all, this is not just one more organic text, but a new text, of considerable pedagogic importance, and it should be a success. The publishers have done their part well. The drawings are beautifully executed.

W. H. HUNTER

Das Anthracen und die Anthrachinone, mit den zugehörigen vielkernigen Systemen. (Anthracene and Anthraquinones, and their Polynuclear Systems.) BY DR. J. HOUBEN, Professor at the University of Berlin, with the coöperation of Dr. Walter Fischer. Georg Thieme, Antonstrasse 15/19, Leipzig C 1, Germany, 1929. xxiii + 890 pp. 17 × 25.5 cm. Price, unbound, M. 85; bound, M. 90.

In the introduction to this comprehensive treatise, Professor Houben states that he began collecting material for such a book over twenty-five years ago, when he was at the beginning of a period of experimental activity in the field of anthraquinone and alizarin chemistry. It is worth while pointing out that it is only because of the rather unusual nature of his association with an industrial firm that Professor Houben's name is little known in this connection, for the value of a book dealing with a phase of chemistry which has been so closely related to the growth of the German dyestuff industry is greatly enhanced by the knowledge that the author brings to the undertaking the authority of many years of collaboration in technical work. The German patent literature affords a source of information concerning anthracene and anthraquinone which is extremely fruitful, but which, because the observations are widely scattered and of unequal reliability, is rather difficult to use. A great service has been performed by Professor Houben in classifying all of this information (to January 1, 1928), in evaluating it in the light of his technical experience, and in combining it in masterly fashion with the material to be found in the non-technical literature.

The book considers first, in a general section, the history, the systems of nomenclature, the structure and the relationship between the structure and the fluorescence of the anthracenes and anthraquinones, while special sections are devoted to the derivatives of anthracene and dianthryl, the quinones, the condensed systems and the radicals of the anthracene series. The anthraquinone dyes are treated fully, though without the inclusion of details relative to the processes of dyeing. The work is characterized by the great care and thoroughness with which the extensive literature has been marshaled and the information systematized. There are over seventy tables summarizing the properties of groups of related compounds, while a useful index to the German patents precedes a very excellent general index. Professor Houben has dealt particularly skilfully with the arrangement of the chapters relating to the very complicated and diverse polynuclear systems; the general properties and methods of preparation of each type of compound are clearly set forth, together with an account of the useful dyestuffs falling within each group.

The book is written in a very clear style, and the reader will derive much satisfaction from the interesting and unhurried accounts of the major investigations of the chemistry of anthracene. The extensive use of full structural formulas and of well-planned diagrams, combined with the beauty of the printing, further adds to the reader's pleasure. There are, for example, no less than 147 formulas illustrative of the principles enunciated in the chapter on the relationship between color and constitution.

A further noteworthy feature of the book is the inclusion of several passages or notes, dealing largely with the technical preparation of alizarin, which were contributed by Professor Iljinsky. The most interesting of these is the account of his discovery of the catalytic action of mercury in the sulfonation of anthraquinone.

Professor Houben's work is not merely an excellent summary of anthracene chemistry, but it also represents a definite addition to this field of knowledge. It is only in this latter aspect that the reviewer can suggest a possible source of criticism, which is that the author has not always succeeded in properly relating the chemistry of anthracene to general chemical theory. On the one hand, the general theory might have been called on more in accounting for phenomena in the special field. Thus the accepted mechanism of the addition of hydrogen chloride and of aniline to quinone might have been applied with profit to the action of these reagents on anthraquinone-azine (pp. 719, 720), and the older mechanism suggested for the Bally benzanthrone synthesis might be revised in the light of the modern view of the ordinary Skraup reaction. Kehrmann's work on the relative oxidation potentials of simple hydroazines [*Ber.*, **31**, 977 (1898)] is perhaps not generally recalled, but it may be said that this work admirably accounts for all of the facts known concerning the relative fastness to chlorine of the indanthrene dyes (p. 729). The reviewer feels that, on the other hand, the opportunity to extend general chemical theory from the facts known about the higher hydrocarbons has not always been utilized fully. The existence of addition products of anthracene with nitric acid and with bromine is surely of significance in connection with the theory of substitution in the benzene ring. Taken by itself, it is difficult to understand the fact that, of all of the monohydroxy derivatives of the simple hydrocarbons, meso-hydroxy-anthracene is the only one which exists largely in the keto form; but when it is recalled that meso-anthraquinone is far more stable than any of the other simple quinones, an adequate account of the stability of anthrone suggests itself: in each case the two benzene nuclei stabilize a quinonoid system.

There is one statement in the book which, though it involves a minor point, cannot be allowed to go unchallenged. It is to the effect that anthraquinone is no true quinone but a diketone. This frequently repeated view probably originated with Willstätter at the time of his brilliant discovery of the quinones of particularly high oxidation potential, and it is easy to see how he came to regard anthraquinone as, to use his conversational word, "träge." He might well have said "sehr träge," but the fallacy is that the adjective used was "zu." The facts are that anthraquinone is a diketone, if a rather inactive one; it is an inactive quinone in the sense that its reduction potential of 0.155 v. is quite low in comparison to the figure of 0.784 v. for *o*-benzoquinone, though it shares with this compound the distinctive property of undergoing reversible reduction with great rapidity.

L. F. Fieser