NEW BOOKS.

Die thermodynamische Berechnung Chemischer Affinitäten von homogenen und heterogenen Gasreaktionen. VON D. IVAR W. CEDERBERG, Privatdozent an der Universität Stockholm. 109 pages. Berlin, 1916. 16 × 24 cm.

The third law of thermodynamics states that the entropy content of solids and liquids becomes zero at the absolute zero of temperature, but makes no statement as to the entropy content of gases. A solution of this latter problem, by further theoretical considerations, is a matter of extreme importance for thermodynamic chemistry. In the book under consideration, using somewhat different language from the above, Cederberg presents what amounts to an attempt to solve the problem of the entropy of gases.

Cederberg believes that Nernst's so-called chemical constant, C, a quantity which is simply related to the entropy of the gas at low temperatures, is equal to the logarithm of the critical pressure, π_0, for the substance under consideration. He first derives a vapor pressure formula by integrating the Clausius equation

$$\frac{d\, ln\, p}{dT} = \frac{L}{RT^2}. \qquad (1)$$

To carry out the integration he writes for the latent heat of vaporization L, the expression

$$L = L_0 + 2.5RT - 3/4\, \epsilon T^{7/4} \qquad (2)$$

where L_0 is the heat of vaporization at the absolute zero and ϵ is a constant characteristic of the substance. This formula for L is based on the assumption that all gases have the heat capacity $^5/_2\, R$ at low temperatures and that the heat capacities of both the gaseous and liquid phase increase proportionally to the three-fourths power of the absolute temperature. Substituting (2) in (1) and integrating he obtains

$$ln\, p = \frac{-L_0}{RT} + 2.5\, ln\, T - \frac{\epsilon}{R} T^{3/4} + C \qquad (3)$$

where C is Nernst's chemical constant. It is this latter quantity which Cederberg puts equal to the logarithm of the critical pressure π_0.

Cederberg shows that Equation 3 fits the vapor pressure data resonably well for a considerable number of susbstances. C he puts equal to $ln\, \pi_0$, and in the majority of cases takes L_0 and ϵ as empirical constants determined by the vapor pressure data. Starting with Equation 3, he also develops methods for calculating heats of reaction, and chemical equilibria in homogeneous and heterogeneous systems.

The reviewer does not believe that Cederberg has presented a completely satisfying solution of the problem he has undertaken. The goal which workers in this field of thermodynamics have set for themselves, ever since the time of Berthelot's unsuccessful attempts, has been to find a

method of calculating chemical equilibria from thermal data alone, without the necessity of making any individual equilibrium measurements. The work of Nernst was an important step in this direction by making such equilibrium predictions possible for *condensed* phases on the basis of thermal data alone. Nernst's chemical constants, however, still necessitated at least a single equilibrium (*i. e.*, vapor pressure) measurement for gaseous equilibria. Cederberg in equating Nernst's chemical constant to the logarithm of critical pressure has merely specified one particular equilibrium measurement which must be made and hence has not provided a solution of the inherited problem.

Serious attention must also be given to an examination of the strength of the evidence for Cederberg's postulated relationship between chemical constant and critical pressure. In the first place it is obvious that Cederberg's Equation 3 is only approximate. The form in which he takes the Clausius equation (1) is of course itself only approximate, and although his assumption that all gases have the heat capacity $^5/_2 R$ at very low temperatures is to be commended, the assumption that the heat capacities both of solids and liquids increase proportionally to the three-fourths power of the absolute temperature is very far from true. Under the circumstances we cannot hope that his method will give an accurate test of his postulate and must regard it as a still unproven, although a very stimulating suggestion.

Except for these criticisms which may be unduly influenced by the reviewer's own particular point of view, the book is to be recommended as a logical and systematic contribution to thermodynamic chemistry. The text seems free from errors, and the numerous vapor-pressure data and equilibria data which are introduced as examples are in a convenient form for reference. RICHARD C. TOLMAN.

Éléments de Chimie Générale. By HENRI VAN LAER, Directeur de L'Institut supérieur des Fermentations de Gand Professeur a L'École des Mines et Faculté de Hainaut. Société anonyme, M. Weissenbruch, Bruxelles, 1919. 433 pp.

The author has not included a preface in his text, nor given any indication except in the title as to its intended field of usefulness. Apparently, its scope would lie somewhere between the more advanced texts in the subject to which we usually refer pedagogically in the United States as General Chemistry, and an elementary text of Physical Chemistry. As a text-book for elementary instruction in these subjects, the work ought to prove a very welcome addition to the French chemical literature which has not hitherto been so plentifully supplied with texts on physical chemistry as has been the case in English and German. The author's style of treatment is simple, clear and non-mathematical. The text abounds with figures and, while many of them partake of the character of free-hand drawings, they are nevertheless clear and frequently present a cer-

tain originality which is not without its attraction. The text is singularly lacking in experimental data; although it contains some 60 odd figures, there are only one or two brief tables in the entire work. The absence of references to the literature also constitutes a serious detraction.

In keeping strictly to the beaten track followed by the texts of a decade or so ago, the author has, in the opinion of the reviewer, lost an opportunity of presenting much material which should not be omitted from the modern text, even of elementary nature, on General and Physical Chemistry. To dismiss the whole subject of the relation of radioactivity to the elements and their arrangement in the periodic system by a few words appended to the usual statement of the law of the conservation of the elements, to omit all reference to the modern theory of atomic structure, of atomic numbers and of isotopes should not prove a welcome omission to the students of the coming generation. These phenomena are not only of fundamental importance, but are capable of simple and non-mathematical treatment, and have already become of much practical interest.

It is also to be hoped that some time within the coming century all authors can be persuaded by some means to index their works.

S. C. LIND.

Laboratory Directions and Study Questions in Inorganic Chemistry. By ALEXANDER SILVERMAN, Head of the School of Chemistry, University of Pittsburgh, and ADELBERT W. HARVEY, Instructor in Inorganic Chemistry. Illustrated. D. Van Nostrand Company, New York, 1919. 102 pp. 20 × 26 cm. $2.00.

The laboratory course presented in this loose-leaf book has been built up during 5 years in the University of Pittsburgh. It contains 55 laboratory assignments and 47 sets of study questions. The titles of the first 18 of the laboratory assignments are quoted to illustrate the character of the course: glass manipulation; physical and chemical change, mixture and compound; purification of substances; oxygen, law of constant proportion; determination of oxygen in air; oxygen and hydrogen, preparation by electrolysis; hydrogen; composition of water, water; water in hydrated barium chloride; osmotic pressure; hydrogen chloride; hydrochloric acid; acid, base, salt; ionization, electrolytes, non-electrolytes; chlorine; acidity of vinegar; chemical equilibrium, speed of reactions; bromine; effect of substances in solution on the freezing and boiling point; etc.

Although it is very difficult to write a set of laboratory experiments which entirely satisfies anyone but the author it is undoubtedly true that the student receives far more benefit from a teacher who has ambition enough to work up an original course than he possibly can from a second-hand course. Not only is this course to be commended on this account, but also because it shows evidence of a great deal of fruitful thought

and labor upon the part of its authors. It is evidently workable, and any student who carries out the experiments outlined will undoubtedly learn a great deal of chemistry.

The following remarks, which the reviewer feels impelled to add, are intended as criticisms of features common to almost all courses in general chemistry, rather than as indicating that the course under review is in any way inferior to others of similar nature.

There are certain ideas emphasized in such courses for the sole reason seemingly that "all of the best people do it." One of these is the distinction between a physical and a chemical change. The writer never sees such a discussion without longing to assume the role of the bold bad student who asks embarassing questions, and talks back to the instructor; a process, by the way, which ought to be encouraged far more than it is.

Again, we usually find an experiment intended to prove the "law of constant proportion," although one hunts in vain for any clear indication of what it is that is able to vary without disturbing the constancy of the proportion.

Again, students are usually taught to deduce the direction of a shift of equilibrium by the aid of a quantitative expression for the mass law which is unnecessary for the qualitative information sought, and which is not true for the strong electrolytes to which it is frequently applied. Of course, if discipline is good, and the student is trained to accept unquestioningly all that he is told, he may not find out the discrepancy till a year or two later.

If our object is to train men so that they will develop the scientific attitude and understand the scientific method should we not avoid experimental "proofs" which prove nothing, statements of "laws" as rigid which are in fact but approximations? Should we not be eager to give the student a realization of the vast and alluring unexplored regions of chemistry and avoid giving the impression that we have chemistry so thoroughly "doped out" that there is nothing for him to do but to learn such portion of our "dope" as we set before him? Would it not be better to sacrifice a little of the ground to be covered for the sake of developing in the student, capacity for reasoning accurately and clearly, for planning and performing experiments, and for observing accurately what the experiment actually shows, not what the book, in its anxiety to preserve him from error, tells him he ought to see?

The book under review is unusually free from this common error of doing most of the student's thinking for him, although it does seem unfortunate that a formula is deemed necessary to enable the student to calculate percentage composition from the weights of the substances involved.

The above remarks should not be interpreted as indicating that the

book is an inferior one, for the contrary is true, and any teacher of general chemistry would be amply repaid for the time spent in a careful examination of it. JOEL H. HILDEBRAND.

Inorganic Chemical Synonyms and Other Useful Chemical Data. By ELTON R. DARLING, M.S., Ph.D., in charge of the Industrial Chemistry Department, Newark Technical School, Newark, N. J. D. Van Nostrand Company, New York, 1919. ix. + 100 pp. 11.5 × 18.5 cm. $1.00 net.

This little book is intended chiefly for the young student of chemistry who finds himself confused by the variety of names given to the more common chemical compounds, but it should also prove to be of value to the business man, who, more or less suddenly, finds that he has to know something about chemicals and their names.

After a short introduction the elements are listed, with symbols, atomic weights, data regarding discovery, and classification into groups. Following this are tables of temperature and specific gravity according to the common systems, with conversion factors. Then come standards of weights and measures in English and metric systems, also with conversion factors.

In the next 70 pages are listed chemical synonyms for certain compounds of the following elements: aluminum, antimony, arsenic, barium, bismuth, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, silver, sodium and zinc; and in the final 20 pages are given some 75 miscellaneous terms, a list of names of certain hydrogen compounds, and a cross index listing about 400 synonyms.

The book is not intended to be complete, and indeed it is very far from complete. Furthermore, the basis for the selection of terms and other information given is a little difficult to understand. The reader undoubtedly will be much interested in learning that bismuth oxynitrate has 12 synonyms, that "spanish white" may be either this substance or calcium carbonate, and that "oil pulp" and "red liquor" are both synonyms for aluminum acetate. One wonders, however, why "kali preparatum" and "yellow wash" are included, and Moore's salt, or tin crystals, or argols omitted; or why so many Latin synonyms are given, and so few compounds of each element and so few elements. Again, in the section on the discovery of the elements it is disappointing to find that nothing is said about tin and sulfur, both exceedingly important elements, and that gold and native copper are not mentioned in the list headed, "Occurrence of the Metals in Nature."

The typography and the makeup of the book are satisfactory, but it is unfortunate that the proof-reading has been done so carelessly. There is scarcely a page without one or more very evident errors, which occa-

sionally may lead to serious misinformation, as on p. 88, for example, where the synonym for "diasotizing (*sic*) salts" is given as sodium nitrate; or as on p. 54, where it is stated that ferric iron has a valence of 4; or as on p. 93, where phosphate of lime is referred to calcium sulfate. A new edition, however, should allow all such errors to be corrected, and, furthermore, should make possible a revision of many hastily written sentences, as on p. 46. "The use of lime in the preparation of mortar for building belongs to the pages of unknown history;" or as on p. 31, "Davy * * * tried to purify the metal * * * " (instead of *prepare*); or as on p. 25, "The litre is equal to a cubic decimeter." There is also some question as to the justification for the author's spelling "phosforus," since both the ph and f are derived from the same Greek letter, ϕ. The table of atomic weights should, of course, be dated.

The book is a sincere attempt to make the way of the student of chemistry a little easier, and as such deserves commendation. The need for summaries, monographs—books which shall gather into small space much scattered information,—is increasing geometrically with the growth of science. This one by Dr. Darling should be welcomed.

WILLIS A. BOUGHTON.

Plant Products and Chemical Fertilizers. By S. HOARE COLLINS, Lecturer and Adviser in Agricultural Chemistry. Armstrong College, Newcastle-on-Tyne (University of Durham). D. Van Nostrand Company, New York, 1919. xvi + 236 pp.

This is one of a series of volumes on industrial chemistry edited by Samuel Rideal, of University College, London. In this the editor and his associates propose to offer "a comprehensive survey of the chemical industries." The editor points out in his general preface, "The rapid development of Applied Chemistry in recent years has brought about a revolution in all branches of technology. This growth has been accelerated during the war, and the British Empire has now an opportunity of increasing its industrial output by the application of this knowledge to the raw materials available in the different parts of the world * * * Each volume will be complete in itself, and will give a general survey of the industry, showing how chemical principles have been applied and have affected manufacture. The influence of new inventions on the development of the industry will be shown, as also the effect of industrial requirements in stimulating invention * * * Present tendencies and possible future developments will have attention and some space will be devoted to a comparison of industrial methods and progress in the chief producing countries * * * * As far as this country is concerned, it is believed that the general scheme of this series of hand books is unique, and it is confidently hoped that it will supply mental munitions for the coming industrial war."

The present volume is divided into 4 parts, dealing respectively, with,

Fertilizers, Soils, Crops and the Production of Meat. The subdivisions of the first part are of Nitrogen Groups of Fertilizers; The Phosphorus Group of Fertilizers, Potassium Group of Fertilizers, Mixed Fertilizers. The second part contains sections on, Soils and Their Properties; Special Soil Improvers; Soil Reclamation. The third part contains 6 sections, namely, Photosynthesis; The Carbohydrates Produced in Crops; The Oil Bearing Plants; The Nitrogen Compounds in Plants; Miscellaneous Plant Products; Produce Variability. The subdivisions in Part 4 are entitled, Manuring for Meat; The Foods Fed to Beasts; Calorific Value of Foods; Dairy Products; Future Developments.

While the discussion of each of the numerous topics included in the book is of necessity brief, the author shows a splendid grasp of his subject. His statements are clear, concise, and very much to the point. He tells us, for instance, "It does not always pay to produce maximum crops, and hence some lands are said to be so fertile as not to need fertilizers. The present war is teaching us that too much reliance may be put upon the economic aspect of food production; that the interests of the nation are not identical with those of the producer." (p. 2.) A few additional sentences may be quoted to show the author's effectiveness of statement; "No soil is perfect; no soil quite hopeless; much can be done to improve the bad, and much can be left undone to injure the good." (p. 3) "The power of fertilizer to act quickly or slowly is a very important property." (p. 4) "In considering the actions of fertilizers on the plant and on the soil it is always important to remember that in no sense is such a series of actions a static matter." (p. 5) "In the vicinity of large towns the sulfur thrown into the atmosphere by the combustion of coal comes down with the rain, washes into the soil, combines with lime, and produces calcium sulfate." (p. 75) "Both maize and rice lend themselves to the possibility of producing starch by the dry methods of grinding and blowing by currents of air, but starch is chiefly made by one of the wet methods." (p. 121).

Some of the author's statements are subject to correction. For example, he claims that solutions of superphosphates or ammonium sulfate "would be absolutely injurious to the plant" when grown in water culture (p. 13). This will depend, of course, on the degree of dilution. In speaking of the impurities in nitrate of soda he fails to mention borates (p. 19). Calcium cyanamide is not "a slow acting manure" as is claimed by the author (p. 22). The author is hardly justified in stating "The really most important member of the group of potassium fertilizers is, however, farmyard manure." (p. 39). It is not true that "A low quality of lime * * * * is of no use for agricultural purposes" (p. 86). All told, however, the author has succeeded in producing a very readable and very useful book.

J. G. LIPMAN.

Qualitative Chemical Analysis. By W. W. Scott. Third Edition, revised and enlarged. 350 pp. Cloth. 13 × 19 cm. D. Van Nostrand Co., New York, 1918. $2.50.

The third edition of this text-book on qualitative analysis varies but little in appearance, plan and scope from the previous edition. Another section has been added, however, which is devoted to a discussion of the reaction properties of a number of the less common elements which, as the author says, "are important on account of their technical use." The contents of the book are divided into 6 parts: Part I, Introduction and the Theory of Analytical Reactions, 25 pp.; Part II, Reactions and Separations of Cations, 128 pp.; Part III, The Anions, 57 pp.; Part IV, Systematic Analysis of a Substance, 29 pp.; Part V, Tables of Reactions of the Metals, 53 pp. Part VI, The Less Common Elements, 30 pp.; Index.

The book contains an unusual amount of data of value to an individual engaged in routine analytical work and will commend itself, therefore (particularly), to those employed in commercial laboratories.

It is the opinion of the reviewer that the majority of teachers would approve of a rather fuller discussion of "oxidation and reduction" and the presentation of the method for formulating these reactions from the standpoint of the ionic hypothesis. The same may be said with reference to the author's treatment of the solubility product. The choice of the mathematical expression of the latter rather than the one involving its expression in terms of concentration seems somewhat unfortunate. Likewise, it is to be regretted that the author makes no reference to the limitations of the statement with reference to concentrated solutions and abnormal electrolytes. The pedagogical usefulness of the book would be increased if the author should see fit to incorporate restatements of these principles and a discussion of their applications to analytical procedures in the "Notes" relating to group separations, etc.

The properties of each base-forming and acid-forming substance are described before taking up the methods for their grouping and separation. However, only those reactions which are to be employed by the student in following the methods outlined for their identification are presented in the general scheme. A more extended list of reactions is presented in Part V. The methods described for the grouping and separation of the cations and anions are similar to those found in most text-books of qualitative analysis. However, many chemists would probably object to the author's inclusion of molybdenum, tantalum, tellurium and tungsten in the hydrochloric acid group. No reference is made to the well-known perchlorate method for the separation of sodium and potassium.

There is an abundance of notes and precautions distributed throughout the book. The mechanical features of the text-book are good and but few misprints were noted by the reviewer. On p. 14, C_2H_4 should be C_2O_4; and on p. 330, in the preparation of stannous chloride, NH_4Cl should be HCl.

RICHARD EDWIN LEE.