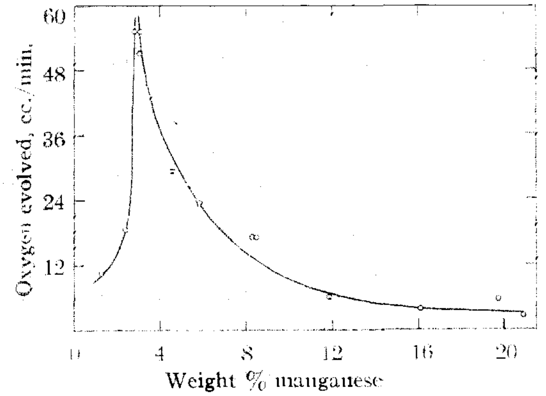

Fig. 1.—Catalytic activity of supported manganese oxides as a function of manganese concentration.

The interest in these results becomes obvious when they are considered in relation to the structural information previously reported. This supported oxide system is one in which the valence inductivity is very strong. At higher concentrations virtually all the manganese is in a +4 oxidation state; at low concentrations it is all in a +3 state. Figure 2 shows catalytic activity plotted against average oxidation state. The oxidation states were found by direct quantitative analysis for active oxygen.

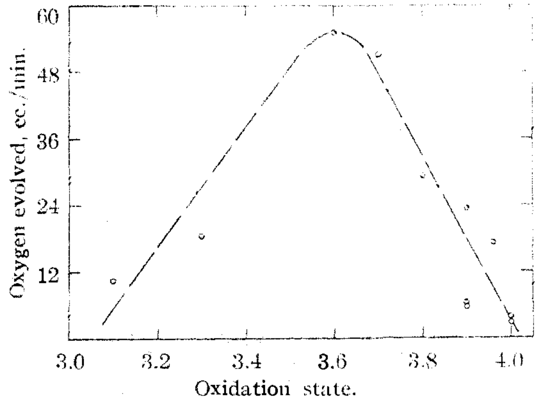

Fig. 2.—Catalytic activity of supported manganese oxides as a function of the oxidation state of the manganese.

It is significant that proton relaxation measurements made on these catalyst samples by the method previously described[2] show no peak of activity, but merely the expected decreasing relaxation time with decreasing concentration. There is a well-defined bend in the relaxation time in the neighborhood of 4% manganese. This parallels the changing effective magnetic moment as the oxidation state changes from +4 to +3.

These catalytic data show the normal increase of activity as the accessibility of the manganese ions increases with increasing dispersion on the support.[3] The sharp decrease in activity below about 3.0% magnanese suggests that a minimum of two adjacent manganese ions is a necessary condition for activity in this system. The fact that the valence inductivity effect becomes strong at precisely this concentration of manganese gives a large number of Mn^{+3}–Mn^{+4} ion pairs. Thus a possible mechanism for the decomposition of hydrogen peroxide may involve the acceptance of an electron from the Mn^{+3}, to form hydroxide ion and hydroxyl radical, followed by donation of an electron by the hydroxide ion to the Mn^{+4} ion. The final stage is transfer of the electron back to the manganese ion which initially carried the $^{+3}$ charge.

Work is in progress on the activity of manganese oxides on aluminas of different specific area[4] and activity[5] and on other supports.

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(2) Spooner and Selwood, *ibid.*, **71**, 2184 (1949).

(3) Selwood and Schroyer, Preprint, Faraday Society Discussion on Heterogeneous Catalysis, University of Liverpool, April 12, 14 (1950).

(4) Eischens and Selwood, This Journal, **69**, 2698 (1947).

(5) Rodier and Rodier, *Compt. rend.*, **230**, 93 (1950).

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BOOK REVIEWS

Hematin Compounds and Bile Pigments. Their Constitution, Metabolism, and Function. By R. Lemberg, Institute of Medical Research, Royal North Shore Hospital, Sydney, Australia, and J. W. Legge, Department of Biochemistry, University of Melbourne, Australia. Interscience Publishers, Inc., 215 Fourth Ave., New York 3, N. Y., 1949. xxv + 749 pp. 16.5 × 23.5 cm. Price, $15.00.

This excellent monograph, dealing with a field in which so many hundreds of investigators have worked, is a highly significant contribution to the scientific literature. It will take its place beside the monograph by Fischer, Orth and Stern as an authoritative reference work in the field. Its scope is broader than the earlier monograph and will appeal especially to biochemists, physiologists and students of the life sciences. Organic and physical chemists, particularly those interested in protein chemistry, will find in it numerous biochemical applications of their specialties and the biological background for a fuller appreciation of the significance of the work which has been done in this basic field. The authors make the point that hemoglobin alone is probably the most extensively studied biological product. This emphasis of investigators indicates the general importance of the subject matter and makes the previous absence of a suitable broad summation the more surprising.

After a brief introduction, the monograph opens with a discussion of the methods of investigation used in the fields to be reviewed, written in collaboration with J. P. Callaghan. This is followed by a discussion of the chemistry of porphyrins, bile pigments and hematin compounds. The hemoglobin problem is then presented in considerable detail from the structural, physical chemical and biochemical viewpoints. The emphasis then shifts toward biochemistry with one chapter on the comparative biochemistry of hemoglobins, two on hematin enzymes and one on the chemical mechanism of bile pigment formation. The emphasis then shifts again toward the more physiological and pathological considerations of hemoglobin catabolism and the formation of hemoglobin and porphyrins in the animal body. The monograph ends with a brief discussion of the pyrrole pigments in evolution.

As each new subject is introduced, the authors follow the pattern of presenting a well balanced summary of the facts from the literature together with the original investigators' interpretations. When these are contradictory or should be superseded in the light of more recent information, the authors add their own interpretations, criticisms, correlations and suggestions. The consistent adherence to this pattern throughout the book marks it as a unique contribution. One of the most interesting sections is that in which the authors correlate the facts and suggestions as to the mode of the biological formation of porphyrins and attempt to develop from them an interpretation which is both qualitatively and quantitatively satisfactory.

The bare statistics on the volume are impressive. The main text covers 654 pages and is followed by a bibliography containing 3182 numbered references and over 450 additional references inserted by lettering or other devices. Thus there is a sustained average of nearly six references per page, not counting repetitions. This bibliography combines information from widely scattered sources and is the basis of the great strength of the monograph. Unfortunately, the book has no author index and the bibliography is not arranged so that it may be used as one. This results in one-way use of this excellent compilation which should be designed for two-way use.

The stated objectives of the authors are to summarize the present state of our knowledge for the student and for workers in other fields, as well as to enable anyone wishing to acquire special knowledge in this particular field to gather the information needed less laboriously than has hitherto been possible. They add that the treatment is as critical as possible and that every endeavor has been made to avoid dogmatic statements.

These objectives have been achieved admirably. There is no doubt that students and workers in other fields will now find it possible to acquire special knowledge in these subjects with a small fraction of the labor that has hitherto been required. The statement that the treatment is as critical as possible is amply borne out by the text. This presents to the reader a sustained, critical evaluation of the hematin literature in the diverse fields of physical chemistry, organic chemistry, analytical methods, biochemistry, physiology, botany and zoology that shows evidence of mature scholarship extending over a prolonged period of time. Whether or not specialists in the fields covered agree with all the conclusions of the authors, there can be no doubt that their presentation is both factual and contemplative and that it will be stimulating and provocative of future research projects.

Alsoph H. Corwin

The Heterocyclic Derivatives of Phosphorus, Arsenic, Antimony, Bismuth, and Silicon. The Chemistry of Heterocyclic Compounds Series. By Frederick George Mann, Cambridge University, England. Interscience Publishers, Inc., 215 Fourth Avenue, New York 3, N. Y., 1950. ix + 180 pp. 15.5 × 23.5 cm. Special price for subscribers to series: $4.20; for non-subscribers: $5.25.

Relatively few heterocyclic derivatives of metals have been prepared. A few of these compounds have achieved some importance in the field of stereochemistry, while others, such as tartar emetic, have been used in medicine. This volume, the first in an extensive series devoted to the chemistry of the heterocycles, deals with the compounds of five metals. Unfortunately, the heterocyclic derivatives of other metals apparently will not be described in this series.

In contrast to the majority of monographs devoted to organometallic compounds the book can be read with considerable interest. This is largely due to the critical appraisal of the literature on the subject, and to the excellent arguments advanced against the doubtful structures proposed by many investigators. Possibly one-third of the compounds listed are introduced by the statement, "these are claimed to have been prepared by. . .," where it is obvious that the author is not convinced of the proof for various proposed structures.

In addition to the critical review of the chemistry of these compounds, an attempt has been made to maintain a logical nomenclature throughout the book. The names given by the original investigators have been changed where necessary in order to maintain uniformity. The *C. A.* nomenclature has been generally used rather than the British system, which the author considers to be inferior. However, the nomenclature is not entirely consistent with *C. A.* usage, *e. g.*, phenylarsenoxide for arsenosobenzene. A particularly noticeable error is the use of the term arsine oxide for an arsenoso compound on p. 116. These deviations are relatively few, and any attempt to maintain uniformity in the naming of organometallic compounds must be highly commended.

The main portion of the book is devoted to the heterocyclic derivatives of arsenic. These include not only the true organometallic compounds but also those in which arsenic is linked to sulfur and oxygen. The stereochemistry of many of these compounds has been considered in considerable detail. The chemistry of tartar emetic and of compounds derived from 1,2-dihydric phenols is discussed at length; but no attempt has been made to list completely all the compounds of doubtful structure formed by the reaction between antimony or bismuth salts and hydroxy acids. Considering the scarcity of reliable data on these compounds the omission can scarcely be criticised.

Few heterocyclic derivatives of phosphorus, bismuth and silicon have been prepared where the structure has been sufficiently established to merit consideration. Only twenty-one pages have been devoted to such compounds. The author makes a plea for further investigation of compounds of these elements.

The book contains relatively few printing errors, is well bound and printed. It will be of extreme value to those chemists still investigating the chemistry of organometallic compounds.

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The Chemical Bond and the Structure of Molecules. By Y. K. Syrkin and M. E. Dyatkina (In Russian). State Scientific-Technical Publishing House of Chemical Literature, Moscow and Leningrad, 1946. 588 pp. 85 figs. 171 tables. 14.5 × 21.5 cm. Price, 30 Rubles.

The reviewer approached his task with great interest since the contact between Russian and Western scientists has been only sporadic for a long time. It was in the pre-wave mechanical era when he spoke on the nature of chemical forces at the Mendelejeff Congress at Moscow in 1925. Thus it was of interest to examine whether the wave mechanical treatment of structural chemistry which, according to the preface, is one of the main goals of the book, differs distinctly from that which has become customary in the English speaking countries.

Study of the book shows that among the wave mechanical interpretations of the homopolar (covalent) type of binding in which shared electrons are involved, the authors consider the Heitler–London exchange method as the most appealing to the chemist. Furthermore, they postulate that the wave nature of the electron and the lack of localization of its orbital motion cause some type of superposition or resonance of several structures in the case of the great majority of the molecules and crystals discussed. While the choice of the structures differs more or less from that of Linus Pauling depending on the individual case, the approach of Syrkin and Dyatkina is characterized by the emphasis on structures intermediate between any two valence bond or ionic resonance states. As an example, the resonance representation of the water molecule may be mentioned. In 1940, Pauling assigned to it the following four structures (and relative contributions): H—O—H (0.37), H^+O^-—H (0.24), H—O^-H^+ (0.24), and $H^+O^{2-}H^+$ (0.15). However, these contribute, according to Syrkin and Dyatkina (p. 250) only the fraction 0.50 to the unique real state of the molecule, while the remaining 0.50 is due to six structures intermediate between each pair of the other types. "Unfortunately, the transitional structures cannot be pictured by valence lines" (p. 105).

As to the nature of the chemical bond, one reads on p. 87, after the treatment of H_2: "The chemical bond is caused by two electrons with antiparallel spins, each of the atoms contributing one electron." However, the discussion on p. 60–73 on $(H_2)^+$ is followed by the statement: "Hence, the simple example of $(H_2)^+$ offers an understanding of the nature of the chemical bond." Since the latter ion contains only *one* electron, the two statements cannot be reconciled with each other. What is common to the treatment of $(H_2)^+$ and H_2 in the present book is the concept of an exchange of the one electron between H and H^+ or of the two electrons between H and H, respectively, leading in each case to two states characterized by the wave functions ψ_a and ψ_b.

With respect to $(H_2)^+$, one learns on p. 72 that "the superposition or resonance of the two states ψ_a and ψ_b causes the formation of three structures: ψ_a^2, ψ_b^2 and of the so-called *transitional* structure $\psi_a\psi_b$." Concerning H_2 one reads on p. 85: "The coulombic energy constitutes only 14% of the calculated energy of the bond. More essential is the exchange energy, which causes the attraction and repulsion of the atoms." The latter sentence must, however, be included in the kind of presentations of the theory of chemical binding, against which the authors themselves warn on p. 88: "The concept of the exchange of electrons led to the incorrect conclusion of the existence of specific exchange forces. In reality there are no exchange forces. In the molecules electric, namely, coulomb, forces are acting."

The main advantage of the Heitler–London exchange method is, according to p. 87, that "in spite of its semi-quantitative character it can be related to chemical pictures and concepts." However, the authors state on p. 73, that the pictorial merits of the method "are to a high degree conditional; exact solution leads to very complicated functions and the electronic cloud does not appear as the sum of the three described parts. In reality there is only one electron cloud in the molecule and its resolution into three structures is nothing but an appeal to simplified pictures." But the claim of simplicity of the resonance pictures appears to be particularly unjustified. On pp. 112–113 one finds reproduced all 42 "canonical" valence bond structures of naphthalene proposed by Pauling and Wheland in 1933. On p. 253 seven structures of ammonia are expressed by partly covalent, partly ionic formulas, while 21 transitional structures, with a total relative contribution of 0.663, are characterized by numbers.

The origin of the concept of transitional structures, not to be found in the English literature, should be explained here briefly. Usually it is simply postulated that it is appropriate to represent the correct but unknown wave function of an unique real molecule by a linear combination of the wave functions of a number of hypothetical valence bond or ionic "structures." However, Syrkin and Dyatkina put the main emphasis on the *density* of the electronic charge distribution, *i. e.*, on the square of the wave function. Since $\psi^2 = (\psi_a + \psi_b)^2 = \psi_a^2 + \psi_b^2 + 2\psi_a\psi_b$, they subdivide (p. 158) the total density into that due to the structures a and b and into the additional density $2\psi_a\psi_b$ which they ascribe to a transitional structure. This difference in the definition of hypothetical contributing structures leads naturally to a difference in the quantitative data concerning their "contributions" (mentioned above for the case of H_2O).

The example of BCl_3 is instructive in several respects. On p. 136 Syrkin and Dyatkina make the statement that the molecule BCl_3 "has" eight structures and characterize them in a definite form as follows: one structure has three covalent Cl—B bonds and will be represented in this review as $(Cl—)_3B$. Correspondingly $(Cl—)_2B^+Cl^-$ represents one of the three structures, each having two covalent Cl—B^+ bonds and one Cl^- bound ionically to B^+. Three further structures of the type $(Cl—)B^{2+}(Cl^-)_2$ are said to contribute little and the eighth one, $B^{3+}(Cl^-)_3$, very little. Intermediate structures are not mentioned but they certainly would have to be considered by the authors in a more complete account.

This cumbersome description of a simple symmetrical molecule is not supported throughout the book by any experimental quantitative or even qualitative data and it differs considerably from the formulas which Pauling proposed for BCl_3 in 1939. In order to bring the Cl—B distance into accord with the postulate of additivity of covalent radii, he assumed three main contributing structures of the type $(Cl—)_2B^-({=}Cl^+)$. Syrkin and Dyatkina do not follow this procedure, probably because they consider (p. 230), as does the undersigned, the concept of covalent radii as lacking theoretical foundation. It is also understandable that they do not include in the table of double bond distances (p. 306) either B or Cl. Thus the choice of their above structures is obviously intended to emphasize the more electropositive nature of B as compared with Cl. Since Pauling's main structures are in contradiction with this relation, he postulated in 1939 enough additional contribution by ionic structures of the type $(Cl—)_2B^+(Cl^-)$ "to make the resultant average charge of the boron atom zero or slightly positive." However, in his "General Chemistry" (1947) it is stated that this molecule is best represented as the resonance hybrid of the structures $B^{3+}(Cl^-)_3$, $(Cl—)_3B$ and $(Cl—)_2B({=}Cl)$.

The complexity, arbitrariness and inadequacy of these resonance formulations is evident. Furthermore, the following statement (p. 105) is misleading: "The resonance of valence bond structure is not an *ad hoc* invented hypothesis but a necessary consequence of the wave properties of the electron." In fact, in spite of the non-localized nature of the orbital motion of the electrons, modern physics succeeded in representing ground and excited states of atoms by unique symbols. Furthermore, in this book, in the treatment of the molecules C_2H_6, C_2H_4 and C_2H_2, for the representation of which the valence scheme was invented, the usual unique formulas are applied. The unique symbol $(B—)_3Cl$ is equally satisfactory from the schematic point of view, but it fails, as do the valence bond formulas of innumerable other molecules and of any molecule ion, to account satisfactorily for their electric properties.

The above objections, raised against the authors' approach to chemical binding and to the electronic structure of molecules, apply only to a lesser extent to the interpretation of the valuable collection of experimental data relating to various properties of substances. Chapter VIII is devoted to the band spectra of diatomic molecules, IX to vibration frequencies in polyatomic molecules, X to molar refractivity and dipole moments, XI to bond energies. The properties are related schematically to definite bonds connecting two adjacent atoms, but different bond schemes are used for discussing such closely related properties as molar refraction and dipole moment, *e. g.*, of the water molecule. The values of the molar refraction (in cc.) of H_2O (3.75) and H_3O^+ (3.04) serve for the derivation (p. 240) of the refractions of the homopolar bonds H—O (3.75:2 = 1.88) and H—O^+ (3.04:3 = 1.01), respectively. However, in treating the dipole moment of H_2O, two homopolar bonds with the dipole moment zero are assumed (p. 250) to be present in only *one* of the 4 (according to Pauling) or 10 (according to the authors) structures of H_2O, the relative contribution of which has been derived to be 0.37 or 0.27, respectively.

In spite of these weaknesses shared with other usual presentations of the subject, the present book may have a clarifying effect. As several of the above quotations indicate, the authors stress more emphatically than is customary the semi-quantitative character of the Heitler–London method, based on the representation of an unique state of a molecule as a function of two or more other states, and criticize even the pictorial value of this procedure. In spite of that, this method is used abundantly and in a purely qualitative manner throughout the book. The main justification for writing "resonance structures" for compounds for which no adequate unique valence bond formula can be found is to preserve the venerable "bond" of classical structure chemistry. However "transitional structures" which cannot be represented by the usual symbols lack even this justification. Thus the appearance of the Tables on pp. 129–137, although they represent only an abbreviation of the more complete enumeration of transitional structures given in the original papers of Dyatkina (1940–41), may have a sobering effect on the followers of the maxim that "the convenience and value of the concept of resonance in discussing the problems of chemistry are so great as to make the disadvantage of the element of arbitrariness of little significance."

In conclusion a few remarks should be added about the question raised at the outset regarding the effect the unfortunate lack of contact between Russian and Western scientists had on the development of the subject. The undersigned has not found in the book anything that differentiates the philosophy of the authors from that of Western scientists, and even in the physical and chemical approach the above-mentioned divergencies as compared with the usual presentations in the English language are not of an essential nature. About 10% of the index of names is composed of chemists and physical chemists working in the Soviet Union, among whom a notable part are co-workers of Professor Syrkin in the field of Raman Spectra and dipole moments. The authors are very well acquainted with the Western chemical literature and although the reviewer hopes to have made it sufficiently clear that he disagrees whole-heartedly with the main emphasis of the book, he is glad to recognize that the authors treat the subject from the standpoint adopted by them as objectively as the inherent contradictions of the latter make possible. Other methods of treatment, including the molecular orbital theory (pp. 157–170), are at least mentioned.

The selection of experimental data is good and the book contains in this respect a wealth of information. The quantitative methods of the resonance approach and of related subjects are treated in the text more extensively than in other books of this type and Chapter XVIII (pp. 529–567) constitutes a mathematical appendix. Thus the book can be recommended to readers who have sufficient background for a critical evaluation of the material presented. However, the "broad circle of chemists" and university students of chemistry for whom the book is said to be designed will not find in it a clarifying viewpoint concerning either the physical nature of chemical binding or the electronic structure of molecules.

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Structure of Molecules and the Chemical Bond. By Y. K. SYRKIN and M. E. DYATKINA. Translated and revised by M. A. PARTRIDGE and D. O. JORDAN. Interscience Publishers Inc., 250 Fifth Avenue, New York 1, N. Y. Butterworths Scientific Publications, London, 1950. x + 509 pp. 15.5 × 24.5 cm. Price $8.75.

The Russian original of the present book, published in 1946, was reviewed in THIS JOURNAL, 72, 4335 (1950). According to the preface of the translators, revisions have been made, apparently without the possibility of contacting the authors, "only where it is apparent that advances in the subject, made since the publication of the original work, have extended or necessitated a modification of the views put forward by the authors." Among the parts so revised those dealing with the following subjects merit mention: method of molecular orbitals, spectra of diatomic molecules, covalent radii, hydrogen bond and boron hydrates.

The reviewer has two reservations with respect to the improvement achieved by these modifications. One is due to the conviction that most of the topics involved do not fit into the adopted valence bond treatment and that a decisive advance is only possible by consideration of electric attractive and repulsive forces acting between appropriate parts of the molecules. This may be illustrated by the attempts of designing an electronic structure for B_2H_6 that conforms with its bridge-structure geometry. The translators criticize (p. 396) the authors' representation of B_2H_6 by 14 resonance structures, in 12 of which one B is negative and one H positive. They have objections also to Pitzer's protonated double bond structure, among others because "from this structure [in which the two B are negative and two H positive] acidic properties are to be expected, but they are not observed." In the next paragraph (p. 397) they express the opinion that Mulliken's molecular orbital structure "which is really identical with the [just criticized] protonated double bond structure," "appears most satisfactory." Such contradictions can be avoided by the electronic structure $(H^-)_2B^{3+}(H^-)_2B^{3+}$-$(H^-)_2$, the bridge configuration of which was indicated by Van Arkel and De Boer as early as 1924.

Another reservation is related to the opinion expressed in the review of the Russian text that its main value, as compared with the customary presentations in the English language, consists in the critical remarks of the authors (some of them were quoted in the review) concerning the foundations of the point of view adopted by them. It is regrettable that most of such remarks have been either completely omitted by the translators, as *e. g.*, that on p. 88 (p. 67 of the English edition) concerning the nonexistence of exchange forces, or changed and weakened so much that the critical attitude of the authors became unrecognizable. The latter applies, *e. g.*, to the section on covalent "radii," pp. 227–231 (pp. 189–192, respectively).

Except for these evidently intentional changes, the translation is very satisfactory. Only one place occurred to the reviewer in which the translators missed the meaning of a Russian word as well as that of the author's statement. On p. 81 in the sentence "Knowledge regarding the localization of valency bonds in molecules appears unsatisfactory in a number of cases" the two first words should be replaced by "The concept of". The very misleading statement on p. 54–55 that in a covalent bond "the electron cloud shows a lower [instead of "increased" of the original] density in the region between the nuclei," is obviously a slip of the pen. On p. 316, as in the original, the Madelung constant for the NaCl structure is given as 1.74456 instead of 1.74756.

The make-up of the book is very pleasing.

For reasons explained in the review of the Russian original and aggravated by the above-mentioned repression of the authors' critical remarks, large parts of the English translation can be recommended only to very critical readers.

DEPARTMENT OF CHEMISTRY
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Gmelin's Handbuch der anorganischen Chemie. 8th Edition, System No. 10-B, Selen (Selenium). Editor, E. H. ERICH PIETSCH; Collaborators, Matthias Atterer, Krista V. Baczko, Erna Hoffmann. Published by Gmelin-Verlag, G.m.b.H., Clausthal-Zellerfeld, Germany; (United States Representative, D. R. Stein, 105 Pinehurst Avenue, New York 33, N. Y.) xxviii + 195 pp. Price, $16.25.

By agreement with Verlag Chemie, former publishers of the Gmelin Handbuch, this installment is published by Gmelin-Verlag Clausthal-Zellerfeld, who will continue the publication of volumes dealing with elements not yet covered and of photostatic reprints of previous volumes destroyed during the war.

The present installment covers the compounds of selenium with elements of lower "system number," namely, the noble gases, hydrogen, oxygen, nitrogen, the halogens, and sulfur. The presentation maintains the high standards of clarity and completeness characteristic of the earlier installments, and this volume is, therefore, a necessary addition to any library which aims at an adequate coverage of descriptive inorganic chemistry.

With this installment the chemistry of over half of the elements has now been described in some 23,000 pages of text plus 9,000 pages cataloging the relevant patents. Of the 28 elements still to be covered, not counting those discovered in connection with the atomic bomb, installments dealing with 14 of them are now in press. In this situation, and with the staff of some 80 scientists and technicians stated to be now at work on this project, one can hope for a relatively rapid completion of the eighth edition of this invaluable compendium of inorganic chemistry.

ARTHUR B. LAMB

Tables de Constantes et Données Numériques 1. Constantes Sélectionnées. Longueurs d'onde des Émissions X et des Discontinuités d'Absorption X. By Y. CAUCHOIS, Maître de Conférences à la Faculté des Sciences, Paris, and H. HULUBEI, Directeur de Recherches au Centre national de la Recherche Scientifique, Paris. Hermann and Cie, Éditeurs, 6, Rue de la Sorbonne, Paris 6, France. U. S. Agent: Stechert-Hafner, Inc., 31 East 10th Street, New York 3, N. Y. 1947. 204 pp. 21.5 × 27 cm. Price, 1000 Fr. frs. (price in countries other than France is 20% greater).

This handbook of X-ray spectral lines is a useful tool for workers who need a uniform tabulation of spectra. It is a compilation of spectra from literature published since 1931 and of values from Siegbahn's "Spektroskopie der Röntgenstrahlen," 2nd German edition, Berlin, 1931. The latter values were accepted if no new precision was added after 1931. In four pages of text the authors discuss their selection of data, the notation used (with reference to their attempt to clear up some of the confusion surrounding non-diagram lines), and the presentation of data and bibliography. Preference was given to series of measurements rather than to isolated data and, in the case of equal precision, to measurements made in the author's laboratory. The precision of individual numerical data is not given explicitly but the authors state that the probable error probably bears on the last figure retained in the wave length. They also state that the doubtful figures were discarded when the estimate of error given by the experimenter seemed too optimistic. There are 193 pages of tables including wave lengths of diagram lines, absorption limits, and non-diagram lines (arranged according to increasing wave length) together with such pertinent data as the designation of the transition involved, the calculated frequency in Rydberg units and its square root, the order of reflection, and a bibliography reference. Wave lengths for the K, L and M series are repeated in charts as a function of atomic number.

GLADYS R. WHITE

Multi-Enzyme Systems. By MALCOLM DIXON, Ph.D., Sc.D., F.R.S., reader in enzyme biochemistry at the University of Cambridge. Cambridge University Press, 51 Madison Avenue, New York 10, N. Y., 1949. x + 100 pp. 12.5 × 18 cm. Price, $1.75.

This important little book will be of interest to everyone working in biological sciences and associated fields. It should also be read by anyone interested in a lucid explanation of the work that is now being undertaken in the enzyme field. The text of the four lectures is given as a quotation from Sir Frederick Hopkins: "I will ask you to consider whether catalysis on highly specific lines is not among the most fundamental and significant phenomena in nature. . . .The organizing potentialities inherent in highly specific catalysis have not, I believe, been appraised in chemical thought. . . .Highly specific catalyses determine just what particular materials rather than any others shall undergo change. . . .I would like to claim that the control of events by intracellular enzymes. . .by itself secures the status of the cell as a system which can maintain itself in dynamic equilibrium with its environment. . . . The inter-related activity of highly specific catalysts represents a notable device of nature which has supported during the course of evolution those dynamic manifestations which characterize living things."

In the first lecture this text is developed, and it is pointed out that most soluble protein is enzymatic in nature. The differences between the consecutive and the shuttle type of coupling mechanism are clearly explained and illustrated by simple experiments. The glycolysis system and the mechanism of carbohydrate utilization are tabulated and discussed.

The second lecture is concerned with hydrogen transfer systems (energy generation) and phosphate transfer systems (energy storage and utilization). The third lecture is devoted to an extension of W. Mansfield Clark's *r*H scale (created for another purpose) to the treatment of redox potentials in biological systems. It is shown that this system has many advantages in the presentation and correlation of the energy relations in hydrogen transfer systems. This treatment is continued in the fourth lecture, and a provisional *r*P scale is proposed for the "phosphorase" systems. The application of *r*H and *r*P scales to biological systems as outlined in these lectures appears to be very worth while to the reviewer. This small book has the one disadvantage that there is no bibliography.

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BOOKS RECEIVED

July 10, 1950–August 10, 1950

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H. MARK AND A. V. TOBOLSKY. "Physical Chemistry of High Polymeric Systems," Second Edition, High Polymers Series, Volume II. Interscience Publishers, Inc., 99 Livingston Street, Brooklyn 2, New York. 1950. 506 pp. $6.50.

JAMES W. MCBAIN. "Colloid Science." D. C. Heath and Company, 285 Columbus Avenue, Boston 16, Massachusetts. 1950. 450 pp. Text Edition (D. C. Heath and Company) $6.00; Trade Edition (Reinhold Publishing Corporation) $8.00.

J. R. PARTINGTON. "An Advanced Treatise on Physical Chemistry," Volume One. Longmans, Green and Co., Inc., 55 Fifth Avenue, New York 3, N. Y. 1949. 943 pp. $16.00 (instead of $25.00 as stated in review in July, 1950, issue).