tremely clear and gives the impression of having been very carefully prepared. In this regard, the reviewer would have only one suggestion—that greater use might be made of graphical illustrations of the type so convincingly employed in Gurney's book. For example, for the case of hydrogen, a plot of $-1/r+l\ (l+1)/2r^2$ for various values of l, with the radial eigenfunctions superposed on the respective energy levels, renders very plausible the coincidences of these levels in this case and the lack of coincidences if the central field departs in the least from the Coulomb value.

Finally one might remark that the typography of the book is very pleasing and should serve as a model for other American texts. It approaches the English and German books for beauty of format, avoiding the ugly fat radicals, the huge thick integral signs and the black summation signs which so clutter up the pages of most American physics books; and goes far toward making the cuts and equations fit into and become an attractive part of the page instead of standing out like trees in the middle of South Dakota. One even finds (p. 515) an equation pleasantly protruding into the margins, a thing unheard of in American typography. One still finds, however, too much blank space around short equations (*e.g.*, p. 355).

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USES OF CHEMICALS

Uses and Applications of Chemicals and Related Materials. By THOMAS C. GREGORY. vi + 665 pp. New York: Reinhold Publishing Corporation, 1939. $10.00.

TWENTY-FIVE years ago, when we entered the World War, it became necessary for the Secretary of War to commandeer all supplies of various essential chemicals and allocate them according to our war needs. This allocation was made with the assistance and upon the advice of the Chemicals and Raw Materials Division of the War Industries Board. Even in a group of experts of this kind, it was not always possible to find men who were familiar with all the varied uses of a well-known chemical or the proportionate amounts required by various industries. For example, those not specialists had no idea of the quantity of arsenious acid required by the glass manufacturers or of saccharin by the tobacco industry.

Such a book as the one under review would have been very helpful, and it seems to the writer, therefore, that its appearance is opportune, now that we may be facing problems similar to those of 1917–18.

The volume describes, in alphabetical order, the current industrial uses, potential applications and sales possibilities of 5,167 chemicals and related products. It is based upon surveys made over a period of 15 years and published in the *Oil, Paint and Drug Reporter,* under the titles *"Where You Can Sell"* (up to and including the issue of September 9, 1935) and "Industrial Uses of Chemicals and Related Materials" (from the issue of September 16, 1935, onwards). The uses are classified under appropriate sub-headings, synonyms and foreign names are given, and patent references are frequent. At the close of the volume is an extensive "Synonyms and Cross References" index. The book is an encyclopedia of useful information.

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SPECIAL ARTICLES

THE SEMIQUINONE RADICALS OF METHYLENE BLUE AND RELATED DYESTUFFS

THE occurrence of free radicals, designated as semiquinones, as intermediate reduction products of reversibly reducible dyestuffs, was considered as an exceptional case when it was first discovered for pyocyanine and some related phenazin derivatives. Meanwhile, these radicals have been shown to exist for all the more familiar classes of reversible dyestuffs, except for the thiazines and oxazines. Since methylene blue, a thiazine, is the most frequently used dyestuff in biochemical research, the failure of any report about the existence of its semiquinone was somewhat puzzling. This problem is especially important with regard to the hypothesis of compulsory univalent reduction[1] which claims that no oxidation or reduction can proceed with any appreciable speed otherwise than in univalent steps. The faculty of acting as a catalyst for oxidation, especially respiration, should accordingly also be correlated with the faculty of the catalyst to be either a univalent oxidation-reduction system, such as the iron porphyrin compounds; or if it be a bivalent system, to be reducible in two successive, although more or less overlapping steps.

This note is to give a preliminary report on the discovery of the hitherto unknown semiquinones of these dyestuffs.

According to the theory on stability of free radicals, based on the theory of reasonance, the authors came to the conclusion that the radicals of thiazines should be most stable in a very strongly acid solution. This expectation has been verified by experiment. It is easiest to demonstrate the radical of thionin (Lauth's

[1] L. Michaelis and C. V. Smythe, *Ann. Review Biochemistry,* 1938.