

mycin, 0; dihydrostreptomycin hydrolyzate, 1.

The presence of at least two aldehyde groups and a terminal methyl group in the central moiety,  $C_8H_8O_5$ , of streptomycin, together with the lack of chemical evidence for a hydroxyl group, indicates that this portion probably possesses two carbon chains linked in a polyacetal type of structure.

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### THE ELECTRIC MOMENT OF *n*-BUTYLLITHIUM AND THE NATURE OF THE LITHIUM-CARBON BOND

Sir:

Despite the wide interest in the reactions of organolithium compounds, little information is available as to the nature of the metal-carbon bond in these compounds and conflicting opinions have been expressed. Thus, Morton,<sup>1</sup> in a recent review, has chosen to regard all organoalkali compounds as salts, although lithium alkyls and aryls are soluble in non-polar solvents, can be distilled, and conduct poorly in solution in zinc alkyls.<sup>2</sup> We have made some measurements of the molar polarizations of *n*-butyllithium in benzene solutions which provide information on this subject and report them here since the work was temporarily interrupted before it could be extended to include other solvents, other lithium compounds and experimental values of molecular refraction.

Using our value, 40, for the molar polarization of *n*-C<sub>4</sub>H<sub>9</sub>Li in benzene, and estimating a value of 1.0 for the atomic refraction of lithium, we calculate a value of  $\mu = 0.97D$  for the dipole moment of *n*-butyllithium. This indicates that the Li-C bond must have considerable covalent character, since ion pairs would result in very much higher values of the molar polarization (*e. g.*,  $P_\infty = 1309$  for LiClO<sub>4</sub>, a largely polar compound, in dioxane solution<sup>3</sup>). From the electronegativity difference, 1.5 units,<sup>4</sup> between carbon and lithium, one would predict about 45% ionic character for the Li-C bond and a bond moment of about 1.5*D* (Malone's rule, *ref. 4*, p. 68). The observed bond moment is 1.37*D*, assuming the C-H bond moment to be 0.4*D* and taking lithium as the positive end of dipole. Lithium alkyls may thus be regarded as covalent compounds, just as organic fluorine compounds are, the rather large amount of ionic

(1) A. A. Morton, *Chem. Rev.*, **35**, 1 (1944).

(2) K. Ziegler, F. Crössmann, H. Kleiner and O. Schäfer, *Ann.*, **473**, 1 (1929); Hein, *et al.*, *Z. anorg. allgem. Chem.*, **141**, 161 (1924), and earlier papers.

(3) M. G. Malone and A. I. Ferguson, *J. Chem. Phys.*, **2**, 99 (1934).

(4) Linus Pauling, "Nature of the Chemical Bond," Cornell University Press, Ithaca, N. Y., 2nd ed., p. 64.

character of the Li-C bond being about equal in magnitude to that of the C-F bond.

*n*-Butyllithium was prepared by stirring a benzene solution of *n*-butyl chloride with an excess of lithium sand for two days. The solution was filtered and transferred to the dielectric constant cell for measurement; the apparatus and technique have been described<sup>5</sup> previously. The density was determined, and aliquots withdrawn and analyzed acidimetrically. All handling was done in a carefully dried, all-glass apparatus, through which dry, oxygen-free nitrogen was continuously passed.

Solutions containing mole fractions 0.06685, 0.03055, and 0.02073 of *n*-butyllithium had densities 0.87098, 0.87035 and 0.87210, and dielectric constants 2.3371, 2.3000 and 2.2946. Extrapolation of the molar polarizations 36.8, 38.0, 39.3 to infinite dilution gave  $P_\infty = 40.0$ . Assuming the atomic refraction of lithium to be 1.0,  $M_{R_D}$  was estimated to be 20.6 and  $\mu$  is calculated to be 0.97 *D*.

(5) Max T. Rogers and John D. Roberts, *THIS JOURNAL*, **68**, 843 (1946).

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RECEIVED NOVEMBER 12, 1946

### STUDY OF FERTILIZER UPTAKE USING P<sup>32</sup>

Sir:

A small amount of P<sup>32</sup> in the form of phosphoric acid was converted to ammonium phosphate and added to an aqueous solution of ammonium phosphate fertilizer. This was used in place of the usual fertilizer in a field experiment using wheat. The wheat was sown with fertilizer in a completely randomized plot on April 29th. The plants grew well and were harvested at intervals. On each occasion, five replicates, consisting of five plants each, were harvested.

The plants were ashed and the fertilizer uptake determined from the measured activity, making due allowance for sample thickness and the decay of P<sup>32</sup>. The total phosphorus was measured chemically. The difference between the total phosphorus and fertilizer phosphorus gives the phosphorus taken up from the soil. The results are recorded, in part, in Table I.

TABLE I

	Date harvested			
	June 18	July 8	July 29	August 15
% P coming from fertilizer	19.1	13.4	10.8	6.7
% P from soil	80.9	86.6	89.2	93.3
% fertilizer taken up of the total added to the soil	12.9	21.3	23.7	23.6

Thus, by using radioactivity as an analytical tool, it is possible to measure the phosphorus taken up from both fertilizer and soil and the utilization of the fertilizer phosphorus, something which could not possibly be done by ordinary chemical means,

We are grateful to the National Research Council of Canada for generous support of this work.

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## NEW BOOKS

**Scientific Societies in the United States.** By RALPH S. BATES, Ph.D. Massachusetts Institute of Technology Press: John Wiley and Sons, Inc., 440 Fourth Avenue, New York, N. Y., 1945. vii + 246 pp. 15 × 22.5 cm. Price, \$3.50.

In pondering the subject of "Books," one may well raise in mind three questions: (1) why write a book, (2) what to write it about, (3) whence the material of which to construct it; (1) and (2) being settled, where does one seek material for (3). The sources may be many-fold and the yield from each variable; Dr. Bates certainly has sifted a multitude of sources (more than 500 are listed), and therewith compiled in five chapters what seems to be a very complete, authoritative and well-documented history of United States societies, large and small, ancient, honorable, ephemeral and recent.

Chapter I on "Scientific Societies in Eighteenth Century America" begins with a background mention of pattern and precedent, from European societies. The "Boston Philosophical Society" (about 1685) of transient existence, seems to have been the first, followed by Benjamin Franklin's "Junto" (1727), parent of the "American Philosophical Society" (1743-1744), which withstood some lean and dormant times to become the oldest scientific society still in existence in our country. The "American Academy of Arts and Sciences" (1780) in Boston came next, and many others followed, transitory and permanent. Many medical societies were among them, usually and logically of local interest, and many state societies and academies, often chartered by state legislatures. Agricultural, mechanic arts and engineering societies began to be formed even before 1800.

Chapter II is entitled "National Growth, 1800-1865," and it was during this period that the country and its scientific society roster expanded from the Atlantic over the Appalachian ranges to the Ohio, Mississippi and Missouri valleys, over and around the Rocky Mountains to the Pacific Coast. Lyceums, medical societies and state academies of science were the usual new organizations, for the age of permanent specialized pure science bodies was not yet at hand. The author has organized the material in this chapter largely on a state-to-state basis, and the result is impressive. Significant names appearing in this chapter are: Silliman's *American Journal of Science* (1818), the American Medical Association (1847), James Smithson, Joseph Henry and the Smithsonian Institution (1846), American Association for the Advancement of Science (1848), the National Academy of Sciences (1863).

Chapter III, "The Triumph of Specialization, 1866-1918," reveals "three main developments. First, the keynote of the period was the tendency toward specialization; second, . . . a slow but sure drift in the direction of national centralization within the specialties; and, third, . . . an increasing tendency to form strictly technological societies . . ." This period saw science come of age, and in so doing

refute the famed saying of Sir William Crookes. The growth of scientific societies kept pace, with many of the new ones enjoying existence to the present day, and many of the older ones broadening their activities.

Chapter IV considers "American Scientific Societies and World Science, 1919-1944," and presents a summary of scientific work in this period accompanied by mention of the many new organizations founded, some of them serving to correlate the efforts and interests of related groups.

Chapter V is titled "The Increase and Diffusion of Knowledge," and deals with the American system of federated societies, as applied by local and national cooperating groups.

A bibliography of 28 pages and extensive index complete the 246-page volume. For a work of its type errors of fact or date seem to be very scarce, as well as typographical ones, the reviewer having noted merely "lyecums" on p. 36, "James Cutbrush" on p. 53, while Webster's Unabridged gives James Clerk-Maxwell rather than J. C. Maxwell (pp. 32, 87).

ALLEN D. BLISS

**Aqueous Solution and the Phase Diagram.** By FREDERICK FIELD PURDON and VICTOR WALLACE SLATER, B.Sc., F.R.I.C., M.I., Chem. E. Longmans, Green and Co., Inc., 55 Fifth Ave., New York, N. Y. 1946. iv + 167 pp. 19 × 25.5 cm. Price, \$7.00.

This book discusses the practical construction and use of the more important types of phase diagrams for aqueous salt solutions, with minimum attention to theory and derivation. By starting with the simplest problems of binary systems, and with what seems at first to be a surfeit of detail and explanation, the authors gradually proceed to a surprisingly clear and instructive presentation of quaternary and quinary diagrams. The principles are old and the methods well known, or at least long published. But the field is nevertheless one of deceptive simplicity, and both the student and the investigator in the heterogeneous equilibrium of salt solutions should find the book interesting and helpful.

The scope is much more limited than the title implies. It deals entirely with isothermal phase diagrams of condensed, single-liquid systems of simple salts and water. Some of the items not included are soap systems, salting out diagrams, effective hydrolysis, boiling point relations, polythermal projections, and even metastability. What is missing in coverage, however, is compensated by the clarity and thoroughness of the treatment of what may be called the problems of "salt chemistry," namely, the use of isothermal diagrams and of their superposition, for the purification, separation and interconversion of salts. The treatment, moreover, involves several unusual features which deserve to be mentioned. The use of specific examples throughout rather than of schematic "A-B-C"