way of presenting papers must have been easier on both the audience and the speakers. The reasons for this are: (1) Most people are able to talk understandably; few are able to read a paper understandably. (2) While talking, the speaker has to formulate his thoughts, which gives the audience a chance to catch up with him. When reading, however, the speaker does not have to formulate his thoughts, and the audience usually does not have enough time to resynthesize words into thoughts.

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SCIENTIFIC BOOKS

THE DESIGN OF HIGH PRESSURE PLANT

The Design of High Pressure Plant and the Properties of Fluids at High Pressures. By DUDLEY M. NEWITT, assistant professor of chemical technology in the Imperial College of Science and Technology. viii + 491 pages, 24.3 × 15.5 cm. 165 figures in the text and 4 plates, with 86 tables in the text and 18 pages of tabular material in the three appendices. Published by the Clarendon Press, Oxford, England, and obtainable in this country from the Oxford University Press, 114 Fifth Ave., New York City, for $10.00.

THE purpose and limitations of this book are doubtless more evident from the title to the English reader than to the American, to whom the use of "plant" in its English technical sense is somewhat unfamiliar. The author attempts no explicit statement of his purpose and limitations, but an examination of the contents shows that its main purpose is to serve as a working manual and complete reference book for the industrial chemist primarily interested in gaseous reactions or other industrial processes such as liquefaction in the range up to 1,000 atmospheres; there is, however, considerable material dealing with liquids up to 12,000. Within its field the book should prove of much usefulness, since the material has never been collected into one place, and much of it is otherwise available only in the original papers.

Consistently with its purpose the book begins with a discussion of the mechanical properties of the materials, mostly steels, from which the pressure apparatus is to be constructed, and the effect of both high and low temperatures on these properties. There follows a chapter, primarily of interest to British readers, on the technical and legal requirements on the cylinders used for the transport of compressed gases. The next chapter discusses the design according to elasticity theory of cylinders for withstanding internal pressure, including built-up and auto-frettaged cylinders; much of this material is valuable and not otherwise easily available. Chapters follow on details of packing, fittings and measurement of pressure. The rest of the book, 360 pages, is devoted to the properties of fluids under pressure and contains much which will interest the physicist not concerned in the narrow technical sense with this field; it is especially to be recommended as a source for numerical data in a course on thermodynamics. There is a full discussion of critical phenomena and the relations between liquid and vapor phases with a discussion of various equations of state. Mixtures of different gases are then discussed. There follow two long chapters on the thermodynamics of gases. Coexisting liquid and vapor phases of binary and ternary mixtures are then treated. M. Ruhemann contributes an interesting chapter on the liquefaction of gases, in which the emphasis is more on the fundamental thermodynamics than in the rest of the book. Chapters follow on the effect of pressure on the solubility, viscosity, dielectric constant and refractivity of gases. The last 50 pages are devoted to proper liquids, in particular, the effect of pressure on viscosity and refractivity, and the pressure-volume-temperature relationships.

As a whole the book should be of much utility, and doubtless every technical worker will insist on having it where it is available, but in using it allowance will have to be continually made for possible lack of completeness. The scheme by which the material has been selected is not at all clear, and there are omissions for which the explanation is not obvious. The following may be mentioned which struck me because I am personally concerned. There is no mention of any of my own work later than 1929 nor of my book on high pressure of 1931. The result is that there is no mention of determinations of the pressure-volume-temperature relations of some fifty liquids, although my earlier work in 1912 on fourteen liquids is described in some detail. It seems that some mention should have been made of the work of Benedicts on the pressure-volume-temperature relations of gaseous nitrogen over a range much wider than that of other observers, and of the work of Birch on the critical data for mercury at the highest temperature and pressure at which critical points have been measured.

P. W. BRIDGMAN

ABSTRACT ALGEBRA

An Introduction to Abstract Algebra. By CYRUS C. MACDUFFEE. 303 pp. John Wiley and Sons. $4.00.

A CONSPICUOUS mathematical development of the last two decades has been the growth of algebra as a unified science, fruitful in applications to modern physics and chemistry, as well as to other branches of mathematics. The general methods and results of the newer algebra were first made available to professional mathematicians as a whole by van der Waerden's now classic "Moderne Algebra." However, besides being written in a foreign language, this book was far too advanced and compendious to be a suitable text for a standard graduate course in this country.

MacDuffee's new volume is the second noteworthy attempt to provide such a text, the first being Albert's "Modern Higher Algebra." Although it covers much less ground than Albert's book and contains no original material, MacDuffee's book, as its title suggests, affords an easier introduction to abstract algebra than Albert's. By emphasizing the most basic theorems and making no attempt at completeness, MacDuffee drives home the fundamental ideas of modern algebra. And by illustrating each definition with carefully chosen examples, he gives "concrete" significance to them—a difficult feat in so-called "abstract" algebra.

The book is not designed for purposes of reference or for use in advanced seminars. However, considerable ground is covered in the theory of algebraic numbers, including the Kronecker program of developing the real and complex number systems from the rational integers, finite fields, valuations and p-adic numbers. This emphasis gives the book an arithmetic bias, especially in the first 200 pages. The last third is devoted to matrices, concerning which the author has already written a standard reference work, and to linear associative algebras. Like van der Waerden and Albert, the author has in effect presupposed "the traditional" course in the theory of equations, and has not dealt with applications outside the domain of pure algebra.

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SPECIAL ARTICLES

ON LUBIMENKO EXTRACTS OF CHLOROPHYLL–PROTEIN

IT has often been suggested that chlorophyll in the living plant is the prosthetic group of a conjugated protein and that when chlorophyll is extracted with an organic solvent it is separated from the protein to which it was originally attached. When, however, one avoids organic solvents and extracts ground leaves with water or salt solution, one usually obtains not a water-soluble chlorophyll-protein but a suspension of chloroplasts from which the chloroplasts are separated by filtration or centrifugation. A little water-soluble chlorophyll can be extracted from chloroplasts by bile salts[1] and much more by the modern synthetic detergents.[2] But it is not safe to use these reagents for the extraction of native, unmodified protein because they are known to denature proteins.[2]

Probably the most interesting and promising observations concerning water-soluble chlorophyll-protein compounds have been made by Lubimenko,[3] whose paper has never received the attention it merits. In the course of a very extensive survey of the chemical natural history of chloroplasts and their pigments, Lubimenko found that a few plants, in particular the lilies, *Aspidistra elatior* and *Funkia,* yielded on extraction of their leaves with water at his unspecified Russian room temperature not suspensions of chloroplasts but opalescent solutions from which the green pigment was not removed by filtration. Lubimenko gave good evidence that the chlorophyll in his opalescent extracts was bound to protein. His evidence was similar to the evidence that visual purple in the eye is bound to protein.[4]

Following Lubimenko, I ground leaves of a species of *Funkia* found in a local garden with sand, extracted the ground leaves with dilute sodium chloride, removed insoluble material by centrifugation with a Swedish angle centrifuge or filtration through Hyflo Super-Cel (Johns-Manville), and obtained a green opalescent solution in which no particles could be seen with an oil-immersion lens. The chlorophyll in the extract was much more unstable than I had expected from reading Lubimenko's paper. At 20–25° C. an appreciable amount of the chlorophyll in the extract went over into an insoluble form within an hour. This process was greatly speeded up by raising the temperature to 37° C., greatly slowed down by lowering the temperature to 0° C. All operations with Lubimenko extracts should, therefore, be carried out in the cold. Freezing, however, should be avoided, since it makes the chlorophyll-protein insoluble.

I have investigated many plants available in the neighborhood and in the Institute greenhouses and found that opalescent Lubimenko extracts can be prepared from a number of legumes, in particular the Early Golden Cluster variety of bean, *Phaseolus vulgaris* L., and the Black variety of cow pea, *Vigna sinensis* Endl., as well as from the lilies used by Lubimenko. These legumes have the great advantage that they can be grown readily and rapidly in the greenhouse throughout the year from seeds which are al-

[1] E. Smith, SCIENCE, 88: 170, 1938.

[2] M. L. Anson, SCIENCE, 90: 142, 1939: *Jour. Gen. Physiol.*, 23: 239, 1939.

[3] V. N. Lubimenko, *Rev. Gen. Bot.*, 39: 619, 1927.

[4] W. Kühne, in L. Hermann, "Handbuch der Physiologie," pt. 2, Leipzig; F. C. W. Vogel, 3: 264, 1879; G. Wald, *Jour. Gen. Physiol.*, 19: 351, 1935.