

biology is the study of any organism one may see with a microscope. Unicellular algae and protozoa come within its ken, as indeed they do, if only superficially"; "The single cells of yeasts might be regarded as a septate mycelium, if they formed mycelium"; "organisms were discovered, early in bacteriology, which did show branching with considerable regularity; so often indeed that it could not be regarded as inadequate cell wall"; "These [the *Corynebacteria*] formed club-shaped cells, and their mode of division was uncertain; certainly it was some modification of binary fission."

It seems unnecessary further to document my conclusion that the book exhibits such a disregard for the requirements of a textbook that it can only be hoped few students will be exposed to it. One may make allowances for careless writing in an examination paper, prepared under stress; but I cannot condone it in a book intended for the instruction of students. It is an acknowledged fact that many American students have great difficulty in expressing themselves clearly and correctly; and this regrettable situation can be improved only if their mentors set an example. As such, *Modern Microbiology* fails to achieve an acceptable standard.

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Applications of Formulas

Collection of Problems in Physical Chemistry. Jiri Bares, Cestmir Cerny, Vojtech Fried, and Jiri Pick. Translated by Helena Watney. Pergamon, London; Addison-Wesley, Reading, Mass., 1962. xviii + 608 pp. Illus. \$9.75.

Problem solving is one of the most effective aids available both to those who are trying to learn physical chemistry and to those who need to regain their grasp of the subject. Theoretical knowledge acquired from textbooks and from lectures can, with problems, be put to a practical test. Not only does the student learn to use what he knows, but if the problems are good ones, he also deepens and refines his understanding of the basic principles.

Two kinds of problems are useful in this connection. The first requires the student to recall or to modify an ap-

propriate formula and then to substitute numbers correctly into that formula. This would appear to be a rather trivial educational exercise; but it is important that students be able to do it, and many students seem to require some exposure to it. Furthermore, this is likely to be the kind of problem that many students will have to deal with in later life—they may have to correct boiling points for changes in barometric pressure, to estimate molecular weights from freezing-point depressions, and to estimate the heat capacity of a diatomic gas at the elevated temperature of a rocket-engine exhaust. But a second kind of problem is pedagogically far more effective. Here the student is confronted with an unusual and complex situation that forces him to review the derivations of his formulas, to be sure of where they are valid, and to inquire more deeply into the meanings of the concepts of physical chemistry. Such problems can be regarded as minor mental research projects in which the student explores for himself somewhat beyond the limits of what he has been taught.

The book by Bares, Cerny, Fried, and Pick is an unusually extensive and comprehensive collection of problems of the formula-substitution type. All aspects of physical chemistry are considered—atomic and kinetic theory, basic thermodynamics, the states of matter, phase equilibria and chemical equilibria, electrochemistry, reaction kinetics, surface and colloid chemistry, and the estimation of physical properties from molecular structure. Approximately 200 sample problems, usually employing data from original papers, are worked out in full detail. More than 400 additional problems are presented, with answers only, for the student to try on his own. On the whole, the problems are straightforward—one calculates the diameter of a molecule from the gas viscosity, the heat of reaction at 1000°C from heats of formation at room temperature and empirical heat capacity equations, the partial molal volume of sodium chloride from an empirical volume-molality equation, the entropy of hydrogen sulfide from the molecular moments of inertia and vibration frequencies, and so on. Some of the problems are very easy, perhaps serving the useful purpose of giving confidence to weaker students. Others require varying intensities of cogitation. Rarely, if ever, does one see anything that entails the sophistication or the careful consideration of the meanings

of concepts required by some of the problems in Moore's *Physical Chemistry*, which, admittedly, is exceptional in this respect. There is a 47-page appendix that contains a number of useful tables, and tucked into a pocket are three charts that show with some precision how compressibility factors, fugacities, and expansion factors vary with reduced pressure and temperature.

In the foreword the authors state that they have tried to give "as comprehensive a survey of physical chemistry as possible." They have been successful to a considerable degree and have produced a book of value to teachers and students. Perhaps even more particularly this book may be useful to those who need to brush up on the applications of half-forgotten formulas.

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Christmas Lectures

The Unseen World. René Dubos. Rockefeller Institute Press and Oxford University Press, New York, 1962. viii + 112 pp. Illus. \$4.75.

In 1825 Michael Faraday was made director of the laboratory of the Royal Institution of Great Britain. One of his early official acts was to inaugurate a series of lectures, the "Christmas Course of Lectures Adapted to a Juvenile Auditory," whose success established a custom perpetuated by the Royal Institution. Inspired by this tradition, the Rockefeller Institute has begun Christmas Lectures of its own. The first series, in 1959, was delivered by René Dubos, who was chosen by reason of the similarity of his talents to those of Faraday. *The Unseen World* is a beautifully printed and illustrated retelling of Dubos's lectures.

The invisible universe to which the title alludes is that of microorganisms. Dubos's account of its exploration is a small but incredibly rich and luminous verbal tapestry: a fabric compounded of biography, factual and theoretical biology, methodological observations, and philosophical reflections. As I read it, I tried to summarize its contents, but without success. Finally, on page 104, I came with great relief to the author's admission that he was not able to do so, either.

What may be said is that the author's