

A positive, yet disappointing, contribution to education

Solids, Liquids and Gases.
(10-volume course of the Open University)

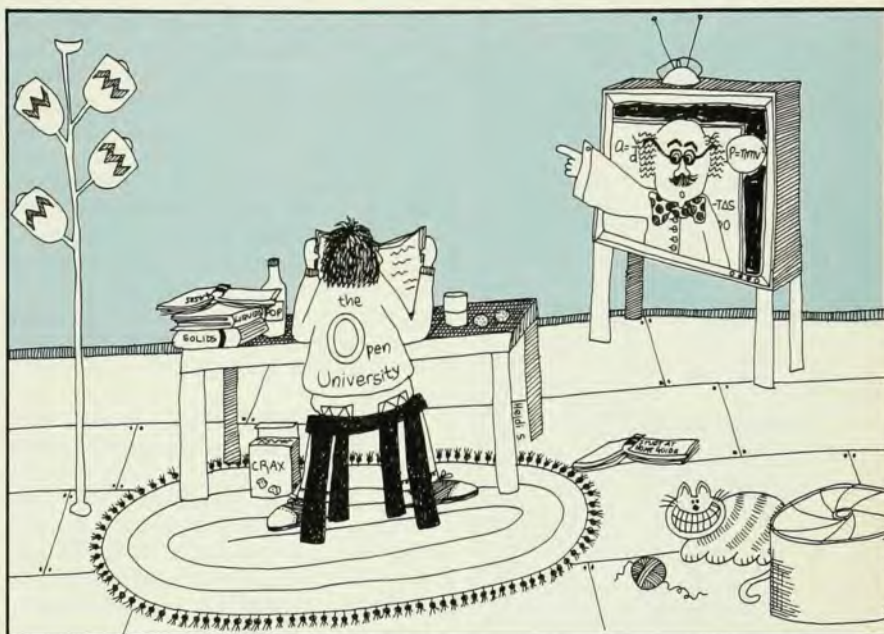
52 to 94 pp. each. Harper & Row, New York, 1973. \$3.25 to \$6.95 each

Reviewed by Arnold A. Strassenburg

To evaluate the 16 units of reading matter that serve as study guides and texts for the Open University course *Solids, Liquids and Gases*, one must know something about the goals and prerequisites of the course. The British Open University offers courses designed for a wide variety of students who, for various reasons, prefer not to live on a campus or to devote full time to their studies. A large fraction of the Open University students who enroll in science courses do so to improve themselves professionally, though a significant number simply want to satisfy their curiosity about DNA, black holes and geothermal energy. The foundation science course treats topics selected from standard introductory college courses in biology, chemistry, physics and the earth sciences. While no background in science is assumed, it is still true of the foundation course, as it is of *Solids, Liquids and Gases*, that the assignments are demanding and credit is only awarded to those who gain a quantitative mastery over the basic laws and theories.

Solids, Liquids and Gases is a second-level course, which means that one or more foundation courses serve as prerequisites. Because the authors of this course assume knowledge of both basic science and mathematics, it is not surprising that they use dynamical concepts and calculus freely and without apology. What is surprising is the sophistication of this presentation. The general approach is one that will appeal to physicists—the fact that physicists are few probably accounts for the small enrollment the course has enjoyed despite the wide applicability of the principles to practical problems.

A prospective user of Open University materials must understand one additional fact. These books were designed to be used with a particular course, not as texts for general college courses in solids, liquids or thermodynamics.



Other components of the course include home experiments (not described in these books), television programs, summer lectures and tutorial assistance (obtained at centers on demand). Even more disconcerting to a casual reader is the fact that substantial portions of the instructional material for some units are contained in other texts. In these cases, the ten Open University volumes encompassing the solids, liquids and gases course include explanatory comments that are meaningless unless one reads the companion texts to which references are made. The orchestration of these various instructional experiences is one of the truly impressive accomplishments of the Open University staff. However, as with any highly specific prescription, the user must follow directions precisely if he is to benefit. A teacher must not expect these books to serve well as texts for the usual undergraduate physics courses taught in US colleges.

Volume one of this series provides a review of the basic laws of classical dynamics that are applicable to the collisions between particles. The pages of the book are well illustrated with graphs and line diagrams, and they are filled with equations involving Newton's laws and conservation principles. There are also numerous self-assess-

ment questions and suggestions as to when home experiments should be performed. The next three units, contained in two paperback volumes, provide a brief but uncompromising treatment of the major results of kinetic theory. There are no gaps in the logic, yet the rate at which new ideas are introduced, the rigor of the mathematics, and the modest amount of explanatory prose are more comparable to senior texts for physics majors than to introductory physics texts. Can a student who has mastered no college science courses beyond the Open University foundation level learn this material through home study? In my opinion, only a very able and highly motivated student will succeed, but even this degree of success makes this course unique among high-quality mail-order courses.

In units 5 and 6 the authors attempt to link two-particle collision dynamics with the equations governing chemical-reaction rates. The effort is strained, and the treatment is an immiscible mixture of equations representing collision theory and empirical descriptions of reaction kinetics. I did not feel that my intuition concerning the structure of solids or liquids was strengthened much by reading this volume.

The next two units treat the elemen-

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tary concepts of solid-state physics. The authors examine ionic bonding and Van der Waals forces with some care; bonding in metals and covalent bonding are mentioned but not treated quantitatively or even described clearly enough to permit an uninformed reader to discriminate between the various kinds of chemical bonding. There is a strong emphasis on working with precise potential-energy functions—clearly the author team was dominated by theorists. (The materials were prepared by a large course team chaired by R. A. Ross and co-chaired by P. M. Clark.) While I concede that a student who is familiar with the approach of a theorist could learn much from this volume, I doubt that the uninitiated will follow the arguments, and I fear that anyone who does, despite numerous warnings, will be lured into a false sense of control over the theory of solids. In fact, I wonder whether there is value in devoting so much time and effort to quantitative treatments that are completely classical.

Units 9 and 10 deal with liquids. Despite the fact that the treatment suffers from the same limitation mentioned above, I learned quite a bit from this volume. This statement probably reflects more the general dearth of quantitative discussions of liquid-state models than it attests to any special excellence of this material. Nevertheless several fine features stand out in this volume. The diagrams and graphs are excellent and they add much to the clarity of the presentation. There are frequent comparisons between theoretical predictions and experimental data. In unit 10 on "Transport Properties in Liquids," the cell model is treated with unusual clarity; the distinction between fact and hypothesis is maintained consistently.

The authors devote the final six units (three volumes) to classical thermodynamics. Compared with most texts on this subject, these are somewhat unusual. They are, as I observed before, the products of theorists—fortunately very competent and articulate ones. Among the exercises, there are few opportunities for students to learn how to apply the basic laws to the analysis of heat-engine efficiencies or to the computation of entropy increases for irreversible processes. There is a sophisticated statement concerning consequences of the second law, and there is a coherent and edifying discussion of phase transitions. In the final unit, a Van der Waals liquid is examined in great detail and compared with other models and real liquids. The entire treatment is interesting and instructive—but not elementary. The major problem here is the absence of concept development. The formal steps by which one deduces consequences from proposed models are

plentiful in these volumes; what is missing is the kind of background discussion of ideas that is essential if this entire subject is to be meaningful to an adult student whose analytical skills have become rusty.

From my perspective as a pedagogue, I see these books as positive contributions to educational change, yet disappointing. Never before have we had at our disposal materials to support a competently taught upper-division course for continuing-education students working independently except for occasional sessions with a tutor. My disappointment is over the opportunity lost. I believe that even with the help of television and the other aids, individuals will have difficulty mastering the course. Even though a great deal of time and effort was invested in its preparation, my hope that the course would accommodate students with a wide variety of backgrounds will probably not be realized.

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A Random Walk in Science

R. L. Weber, compiler; E. Mendoza, ed.
206 pp. Crane, Russak, New York, 1973.
\$12.50

Like many brilliant ideas, this book was inspired by a grievance. For a long time, Robert L. Weber of Pennsylvania State University thought that he and his fellow physicists took themselves much too seriously. So, as an antidote for such pomposity, he began collecting jokes about them and eventually about other scientists as well.

The task was made all the easier by a new phenomenon: the explosive growth in recent years of what Weber calls "the flourishing underground press"—such irreverent, spoofing publications as *The Journal of Irreproducible Results* and *J. V. McConnell's Worm Runner's Digest* ("My own personal joke on the Scientific Establishment"). From these and kindred sources, Weber has assembled enough jokes and short anecdotes to enliven after-dinner speeches at scientific gatherings for years to come. Some examples: Werner von Braun's sardonic definition of basic research as "what I am doing when I don't know what I am doing" and Pamela Anderton's wry comment that the best general measure for science may be not English or metric but the Rule of Thumb.