four on aggregate matter, and seven on the physics and engineering of nuclear devices. Robert R. Wilson's recent appointment to the directorship of the National Accelerator Laboratory makes his "Anecdotal Account of Accelerators at Cornell" particularly timely.

A lecture by Robert Oppenheimer, given not long before his death and bearing the same title as the book, makes especially good reading. Oppenheimer speaks in his very personal, somewhat guarded style, with great wisdom and unusual simplicity, about ideas and ideals that concern us all.

Robert F. Bacher and Victor F. Weisskopf have provided an introductory chapter on the career of Hans Bethe. They have been generous enough to put in print, as footnotes, some anecdotes that in the past have been current only in oral tradition, and they have written as authoritative an evaluation of Bethe's work as one could hope to produce when the subject of the account is still very much on the scene. For, Hans Bethe is not only busy lecturing his students at Cornell and the rest of us at APS meetings, but he is deeply involved in a massive program of calculations on nuclear matter. His bibliography will surely continue to grow, and we can expect his high standards of workmanship to serve all of us as a guide for years to come.

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Eugen Merzbacher, who writes on quantum mechanics, is spending the current academic year as a visiting professor at the University of Washington.

Is science a society?

THE SOCIAL SYSTEM OF SCIENCE. By N. W. Storer. 180 pp. Holt, Rinehart and Winston, New York, 1966. Paper $3.95

by R. Bruce Lindsay

The impact of science on society has been studied in depth for some time, and most scientists believe that they understand its role in this respect. The author, a member of the sociology department at Harvard University, has, since 1961, contributed several articles to the literature on the social aspects of science. In this book he has set for himself a somewhat different field of investigation. He tackles this question: Do scientists as a group form a society with a social system analogous to the great systems recognized by sociologists, namely, those associated with man as an economic, political, religion- and family-forming animal? Storer believes that the answer is yes and has framed an ingenious theory or model to justify his answer.

Having defined a social system as a "stable set of patterns of interaction, organized about the exchange of a qualitatively unique commodity and guided by a shared set of norms that facilitate the continuing circulation of this commodity," the author proceeds to argue that the community of scientists satisfies this definition. The commodity in this case is competent response to created scientific knowledge and the norms are those previously laid down by Robert K. Merton, namely, universalism, organized skepticism, communability and disinterestedness. The emphasis throughout is on basic science as distinguished from applied science. The reviewer feels that this limitation is an unhappy one. There are relatively few individuals who can satisfy the strict creativity criterion laid down by the author, and yet there are thousands of scientists who do make valid contributions to science short of making basic discoveries.

That the majority of scientists would agree that they form a social community is doubtful, but it is at any rate of interest to have the well considered views of a sociologist looking from the outside at their multifarious activities. Among the interesting problems to which Storer directs his attention are professional recognition, the distinction between the genius and the crackpot, secrecy in scientific research, the financial support of science, the growth in number of scientists and the "publication explosion" and its implications for the future of science. Scientists of all kinds will find the book challenging reading.

A SOCIOLOGICAL LOOK at scientists finds science is indeed a society.

* * *

The reviewer is Hazard Professor of Physics at Brown University. He is interested in and has on occasion written about the sociology of science.

For student involvement

PRINCIPLES OF PHYSICS, A PROGRAMMED APPROACH: Vol. 1, FOUNDATIONS OF MECHANICS; Vol. 2, MECHANICS AND THERMODYNAMICS. By Neil Ashby, Stanley C. Miller. 240 pp. and 261 pp. Allyn and Bacon, Boston, 1966. Paper $5.95 each

by Oakes Ames

These two volumes are a contribution to the literature of introductory physics texts that is unique not so much for the choice or ordering of material as for being a programmed presentation. For the benefit of those who may not have encountered this method, the purpose of a programmed text is to involve the student as much as possible in working out the material for himself as he reads. To work through a programmed text requires a measure of self-discipline and sometimes may seem slow going. There is little doubt, however, that if the author carefully develops the steps the reader must take, the end result is an efficient and rewarding method of study. Specifically, the page is divided into two columns, the right-hand one being the text. The text is divid-

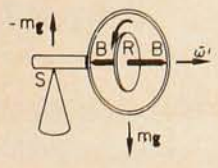
ed horizontally into frames with each frame developing an idea or several closely related ideas. The reader must fill in one or more steps that are left blank. The correct answers are in the left-hand column but shifted down by one frame. If the layout is good, as it indeed is in these volumes, it is remarkably difficult to cheat by letting your eye rove. Those who are not above temptation can easily cover that part of the page below the frame they are studying. The system I am describing, and the one used in these books, is simple because it is linear. A more involved form of programmed text is one in which the student's route through the material is determined by his responses to the questions.

All of the first volume and about half of the second is on mechanics, both classical and relativistic. Calculus is introduced early in the first volume and is employed throughout; thus the material can be used by any student who is concurrently taking an introductory calculus course. The three chapters on special relativity and relativistic dynamics are done in a very thorough and satisfying fashion, ending with a group of bubble-chamber photographs of the decay of a Λ^0 particle into a proton and a π^- meson; the student must analyze these with a protractor and a ruler to obtain the rest mass of the Λ^0.

The second part of Volume 2 does a great deal more than the usual treatment of thermodynamics in an introductory text. Included here is a chapter on probability that introduces such ideas as distribution functions and probability densities. Following this is a chapter on the basic aspects of kinetic theory and a remarkable chapter on classical statistical mechanics. Here the Maxwell–Boltzmann distribution function is derived and there is a discussion of the atomic-beam experiments of Polykarp Kusch and Robert C. Miller (1955) to measure the velocity distribution in a beam.

Each chapter in these volumes is accompanied by 20 to 30 problems, and as the student proceeds through a chapter he is occasionally given advice as to which problems he ought to be able to solve at that point. Each volume also has an appendix that reviews or expands upon mathematical concepts used in the body of the text.

toward 9



Now consider the gyroscope shown. The rotor R spins around the axis mounted on bearings B. The frame is free to rotate about the support S. The rotor's spin angular velocity which we shall call $\vec{\omega}'$ is shown at a particular instant. The force mg due to the weight and the reaction - mg form a _____. The torque N of these two forces is (into, out of) the paper. 10

couple 10

into

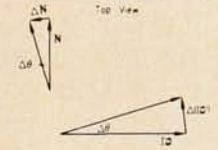
In analogy with the above discussion, $\vec{\omega}'$ tends to rotate (toward, away from) the direction of N. This rotation of $\vec{\omega}'$ is accomplished, of course, by the whole gyroscope rotating about pivot S. This is a motion in which the rotor's axis does not remain pointing in a fixed direction, but the bearing line SBB and $\vec{\omega}'$ rotate in a horizontal plane. The shifting of the direction of $\vec{\omega}'$ is called precession. 11

toward 11

We shall assume the bearings are frictionless; then the magnitude of $\vec{\omega}'$ will remain constant. The vector component of angular momentum parallel to $\vec{\omega}'$ we shall call $L_{\omega'}$; in terms of $\vec{\omega}'$ and the moment of inertia I about the spin axis BB this component is $L_{\omega'}$ = _____. We will assume that all other components of angular momentum remain constant: then only $L_{\omega'}$ has a non-zero rate of change and the equation of motion is $N = dL_{\omega'}/dt = Id\vec{\omega}'/dt$. This also says that the change in $\vec{\omega}'$ is (toward, away from) the direction of N. 12

$I\vec{\omega}'$ 12

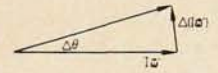
toward



Since we have assumed here that the magnitude of $\vec{\omega}'$ remains constant and only its direction changes, the change $\Delta(I\vec{\omega}')$ indicated in the diagram is due only to rotation of the vector $I\vec{\omega}'$ because the moment of inertia is constant. The torque also rotates so that it is always (parallel, perpendicular) to $I\vec{\omega}'$. 13

perpendicular 13

We let $\Delta\theta$ be the change in angle due to rotation during some small time interval Δt. Then



$$\frac{\Delta L_{\omega'}}{\Delta t} = \frac{\Delta(I\vec{\omega}')}{\Delta t}$$

and from the diagram when $\Delta\theta$ is small, the magnitude of $\Delta(I\vec{\omega}')$ is given in terms of $\Delta\theta$ and $I\omega'$ by

$|\Delta(I\vec{\omega}')|$ = _____ $\Delta\theta$. 14

PORTION OF TYPICAL PAGE from *Principles of Physics, A Programmed Approach*, shows two columns. Answers on the left are one frame below questions on the right.

Reviewed in This Issue

The authors, professors of physics and astrophysics at the University of Colorado, suggest in their preface that the material is designed for an introductory physics course. I should add that it is a rigorous introduction and that much of the material in Volume 2 is presented on a level that makes it quite suitable for use in the sophomore year.

Although the quality of work throughout is generally excellent, there are sometimes unclear figures or photographs. For example, a multiple-flash photograph of a falling weight is displayed for use in measuring g. Displacements measured from the photograph are in poor agreement with the results given in the answer frame of the text. A figure used to illustrate infinitesimal rotations is almost impossible to interpret. These are minor annoyances, however, and do not detract seriously from an otherwise fine presentation.

The programmed approach is an intriguing one; the student is drawn into an involvement with the material that he would be unlikely to achieve with a conventional text. Neil Ashby and Stanley Miller have provided us with a timely and rigorously presented selection of material. It will be interesting to see how well programmed texts such as these succeed in the many new physics courses being developed in our colleges and universities.

* * *

The reviewer is an associate professor of physics at the State University of New York at Stony Brook.

Seitz and Turnbull, 1967

SOLID STATE PHYSICS, VOL. 19. Frederick Seitz, David Turnbull, eds. 381 pp. Academic Press, New York, 1967. $16.00

by Henry M. Otte

FREDERICK SEITZ AND DAVID TURNBULL edited *Solid State Physics* since Vol. 1 was published (1955). With Vol. 20 (1968) Henry Ehrenreich joins them.

As did its recent predecessors, this volume again contains four articles, well written and extensively documented. Two of the articles are concerned with the effects on solids of high pressures, in the one case static and in the other case dynamic; both report and review primarily experimental observations. Reviews on the effects of high pressures have appeared in Volumes 6 (1958), 11 (1960), 13 (1962) and 17 (1965). The emphasis in the other two articles is on theoretical analysis as the principal tool to calculate desired measurable quantities from the mathematical formulation of a physical process. They deal with the effects of crystal imperfections on lattice vibrations and with the interaction between acoustic phonons and conduction electrons. Reviews dealing with aspects of both subjects can be found in previous volumes.

The first and longest article is by A. A. Maradudin (Westinghouse Research Laboratories). Entitled "Theoretical and Experimental Aspects of the Effects of Point Defects and Disorder on the Vibrations of Crystals," it forms the concluding half of his review. The first half appeared in Volume 18 (1966) and together the two halves would have filled a separate volume or supplementary monograph. Maradudin makes numerous references to, and presents the results of work previously unpublished in the open literature. The main sections of part two of Maradudin's article cover impurity-induced infrared lattice absorption in crystals, anharmonic effects in impurity-induced one-phonon infrared lattice absorption, localized modes and spin-lattice interactions and lastly the surface of a crystal considered as a defect. It is clear that in many cases one requires more sophisticated models of the impurity atom than that which represents it simply as a particle whose mass differs from that of the atom it replaces. Otherwise the arguments will be only qualitative and semiquantitative. Maradudin concludes that future work will be concerned, among other things, with explaining experimentally observed effects in which the vibrations of impurity atoms play a role and with theoretical analyses in which the basic approximations (namely, the harmonic approximation and the cyclic boundary condition) are relaxed and directed to maintaining a sustained effort to make the theory of defect atom vibrations more than just a rather elegant mathematical exercise.

"X-ray Diffraction Studies of the Lattice Parameters of Solids under Very High Pressure" is a review by H. G. Drickamer, R. W. Lynch, R. L. Clendenen and E. A. Perez-Albuerne discussing primarily measurements of lattice parameters versus pressure, P, made in Drickamer's laboratory at the University of Illinois. The results are described in terms of Murnaghan's equation

$$P = \frac{B_0}{B_0'}\left[\left(\frac{V_0}{V}\right)^{B_0'} - 1\right]$$

where B_0 is the bulk modulus, B_0' its pressure derivative, both evaluated at 1 atm. pressure, and V_0/V the volume ratios. The constants B_0 and B_0' are listed for all substances where it was practical to evaluate them. Data for 23 crystals having the sodium or cesium chloride structure or slight distortions thereof are presented and discussed; they are grouped as alkali halides, miscellaneous halides, cubic oxides and sulfides, and carbides. Data and discussion is included also for two