modes, modulation, raman lasers, parametric and other nonlinear effects are not mentioned, but the survey of various types of lasers with the exception of chemical and dye lasers, is rather detailed.

The book will be mainly valuable as a convenient reference to a large amount of laser data and pertinent equations from quantum and electromagnetic theory. The typography of the text, equations, tables and figures is very clear, for which the publishers are to be commended.

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Experiments in Physics

L. A. Sander, *ed.*
(4th edition) 169 pp. Pacific Books, Palo Alto, Calif., 1968. $3.95

This book is a manual of elementary-physics experiments, presumably written by university teachers conducting a course in practical physics and intended for first-year students. I say "presumably" because no information is given about the authors or the potential reader.

The manual describes 40 experiments in mechanics, sound, heat, electricity, light and atomic physics. The experimental apparatus appears to have been especially constructed for the course, but an instructor trying to set up a similar course would have some difficulty. In many cases the apparatus is fairly obvious but in others it is not, and a small photograph is the only information given.

The major criticism is that the book contains a large number of careless mistakes. For instance, the answer to the question "What is the power in watts consumed by the iron?" is given as 516 ± 3 volts; the formula for finding the sine of an angle greater than 90 deg is stated as $\sin\theta = -\sin(180 - \theta)$. Also in introducing an experiment on simple harmonic motion, there is a confusion of sign in the basic equation, from which it is deduced that the period of the motion is

$$T = 2\pi\sqrt{-\frac{m}{k}}$$

(I am giving the authors the best of it—the π is omitted in the original.) The minus sign under the square root discreetly disappears in a subsequent equation.

Carelessness on this scale is not to be condoned, but a greater objection can be made to the general spirit of the book. The introduction reads more like a military manual than one intended for physics students, for example: "The data, computations, and notes for all experiments must be kept in the special laboratory notebook. Rules for keeping the notebook are as follows: (a) Make all entries for the experiment on the right-hand pages. Use the left-hand pages for scratch work. Do not use loose sheets of paper. . . ."

This rigidity may well turn many students away from physics, especially the more intelligent ones. Experimenting in physics is not a matter of blindly following a set of rules. Certainly there are good habits that one wishes to inculcate in students, but it is vital for the teacher to get his priorities right. For example, I would say that it is more important that students get into the habit of checking their calculations—a point nowhere mentioned in the manual—rather than writing on a special kind of paper, whether on the left- or right-hand side.

Having made these points, I must add that the experiments are reasonably varied, and that some of the questions are penetrating and thought provoking. Many of the instructions and pieces of advice are sensible. It is a pity that the book should be marred by so much carelessness, itself a prime enemy in practical work, and by the apparent rigid outlook.

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The Physical Foundations of General Relativity

By D. W. Sciama
104 pp. Doubleday, New York, 1969. Cloth $4.50, paper $1.25

Karl Marx said that he turned Hegel's philosophy the right side up (or upside down, depending on your viewpoint). Dennis Sciama proposes to do a similar tour de force with the general theory of relativity.

The usual introductions to general relativity follow a standard path. After a brief discussion of the equivalence principle, one starts to emphasize the geometrical content of the theory. This is because general transformations and invariance are of paramount importance and whatever is not invariant can not be thought of geometrically. In this way one reaches the notion of curved space–time and the field equations. Next there is usually a discussion of geodesics to describe the worldlines of moving bodies. The equivalence of inertial mass and gravitational mass briefly reappears to show that they are automatically the same, because there is no provision in the theory to insert two different mass parameters. Why there is an inertial mass and what determines its value is mentioned briefly under the ambiguous heading of Mach's Principle.

In Sciama's book the process is completely reversed. In the beginning, the notion of inertia and inertial frames appears. (Why is the second derivative of the displacement influenced by external agencies, and not say, the first or the fourth?) Then Mach's Principle is introduced: "Inertial frames are those which are unaccelerated relative to some suitably defined average of all matter in the universe; matter has inertia only because there is other matter in the universe."

How does this matter determine inertial mass? The author suggests that there is a long-range inertial interaction. Its acceleration-dependent part determines the inertial force, its static part the gravitational force; the same parameters appear in both so we get to the equivalence principle. This is all heuristic and attractively done.

Chapter three is an excellent sample of exploratory guessing, strengthened by order-of-magnitude arguments. The big leap is from the heuristic argument to the field equations. The author suggests that the inertial interaction is represented by a nonlinear field derived from ten potentials. The motivation arises from the fact that the source of the field is also characterized by ten functions, and that the nonlinearity is needed to create a gravitational field by its own energy content. (It is not surprising that the discovery of the tensor nature of the gravitational field and the nonlinearity of the field equations can not be told in a few lines. It took Einstein nine years to get from the equivalence principle to the correct field equations, after trying in vain a scalar-field theory first.)

This is followed by an excellent and