Author's Preface

What is physics? Every introductory physics text tries to answer this question in its own way, and this text is no different. However, this book is addressed particularly to readers with little scientific or mathematical background: the only requirements are common sense, experience, and reasoning ability. To make the subject meaningful to this audience, it was necessary to alter the customary approach of most introductory texts.

The usual sequence of topics in introductory physics courses for liberal arts students begins with a study of Newtonian mechanics and its roots in astronomy. There is good reason for starting with mechanics, because Isaac Newton's brilliant achievement three hundred years ago marked the beginning of the interplay of experiment, imagination, and deductive logic that has characterized physics ever since. Unfortunately for the novice, Newton's imaginative leap from observation to formulation of axioms was so great that few can follow it. Introducing Newtonian mechanics at the outset of the course presents an extremely difficult problem for many students. This problem often acts as a deterrent to their full appreciation of physics since many students never realize that other subject areas (for example, heat and temperature, sound, light, elasticity) do not make the same demands for abstract reasoning when they are treated at an elementary level.

To remove this impediment, I have rearranged the subject matter and have placed Newtonian physics at the end of the text. The result is an emphasis on the "interaction" and "energy" concepts rather than on the more abstruse "force" concept; thus, physics is related more effectively to the common sense views of most students entering a beginner's course. The instructor accustomed to the more usual approach will have to be careful to remain within the conceptual sequence of this text.

The book is primarily intended to meet the requirements of a one-semester course for non-science students. It consists of four parts, an epilogue, and an appendix reviewing the mathematical background for the course. Part One is an overview of physical phenomena, which are taken up in more detail in the later parts. A number of fundamental concepts are introduced: scientific models, reference frames, systems, interaction, matter, energy, equilibrium, steady state, and feedback. This initial part lays a foundation for the remainder of the text, and it will be helpful to any beginning student of science whether he continues the study of physics or moves into other areas.

Part Two is concerned with light, sound, radiation, and the structure of atoms. This part introduces the student to twentieth century physics and will enable him to appreciate the many excellent books on relativity theory and quantum physics listed in the bibliographies. In Part Three, operational definitions of energy are used to construct simple mathematical models for thermal energy (specific heat), elastic energy, gravitational field energy, and electric power. Finally, Part Four deals with the Newtonian theory of particle motion relating force to acceleration. Immediate applications of the theory lead to a mathematical model for kinetic energy, to a description of the motion of falling objects, and to an understanding of the action of rocket engines. More extensive investigations include the study of periodic motion (for example, the solar system and the pendulum), gas pressure and heat engines, and the kinetic theory of gases. In this final part, the extensive chapter-end bibliographies will be particularly helpful in guiding the student to further study of topics that interest him most.

It is clear from this survey of the text that its overall organization does not follow the historical development of physics. As previously mentioned, I have been motivated instead by a desire to construct a bridge between the preconceptions of the nonscientific reader and the concepts and theories of physics. In order to provide a helpful and interesting historical context for some aspects of the subject, however, the margins include historical background, biographical notes, and quotations from the works of prominent scientists. Much of this material illustrates the transient nature of most scientific theories and the extensive modifications that scientific models have undergone. What is esteemed by one generation may be discarded by the next!

Although the present sequence of topics is the one I consider most fruitful, the organization of the text into four separate parts (the latter three of which represent fairly independent entities) does allow some flexibility in the order in which these topics may be treated. It is possible, for example, to omit Part Two or to exchange the order of Parts Two and Three. Through such a modification the needs of particular courses or the preferences of the instructor may be met.

The text may also serve as a full year's course. Parts One and Two could be studied in the first semester, and Parts Three and Four in the second semester. To supplement the text material and to expand the course to fit the requirements of a full year's program, selections from the extensive bibliographies could be the focus of many assignments and discussions. These bibliographies also enable the instructor to adapt the course to encompass the diverse interests of the students.

As a final thought, I suggest that the reader begin with a reading of the Epilogue and conclude with Chapter 1. I do not mean that the book should be read backwards. After the Epilogue, the book may be read in the proper sequence, but the reader should return to Chapter 1 after he has read the Epilogue for a second time. By comparing his reaction to these two sections of the book on the first and second reading, he will be able to gauge his progress in scientific literacy.

My work on this book has benefited from the assistance and encouragement of many colleagues, friends, and students, and it is a pleasure to acknowledge them. Abraham Fischler, now at Nova University, teased me into teaching an "impossible" physics course for liberal arts

students and thereby indirectly initiated the project. Thomas Kuhn, Gerald Holton, and the late Francis Friedman of the Physical Science Study Committee strongly influenced my view of what is important in physics. My associates in the Science Curriculum Improvement Study, especially Carl Berger, Joseph Davis, Chester A. Lawson, Marshall Montgomery, Luke E. Steiner, Laurence Strong, and Herbert D. Thier, helped me in selecting and refining my approach to the subject matter. Stephen Williams and Michael von Herzen assisted in the preparation and evaluation of a preliminary edition of this text. Diane Bramwell and my wife Elizabeth contributed to the production of the present edition.

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Robert Karplus

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