TEXTBOOK OF ELEMENTARY PHYSICS

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TEXTBOOK OF ELEMENTARY PHYSICS

Edited

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VOLUME 3

OSCILLATIONS AND WAVES

OPTICS

STRUCTURE OF ATOM

Translated from the Russian

by A. Troitsky

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Part Three

PHYSICAL OPTICS

LIST OF TABLES

Volume 3 of the *Textbook of Elementary Physics* deals with the problems pertaining to the study of oscillations and waves. Mechanical oscillations and elastic waves are followed by a discussion of acoustics. The chapters on electromagnetic oscillations and waves naturally lead to the study of the most important practical applications of these problems—to the discussion of the fundamentals of radio physics and radio engineering beginning with the invention of radio by A. Popov, of the electromagnetic nature of light, and of the principles of wave (physical) and ray (geometrical) optics. The volume ends in a description of the phenomena related to the modern theory of the atom. Similar to volumes 1 and 2, this volume contains numerous problems very important for better understanding the material being studied.

The chapters relating to mechanical and electromagnetic oscillations, acoustics and radio physics were written by S. Rytov, to geometrical optics by M. Sushchinsky and I. Yakovlev, to physical optics by F. Baryshanskaya, and the part relating to the atom by F. Shapiro.

As in the previous volumes, we did everything in our power for the student to understand the physical essence of the phenomena being considered. Mathematical deductions again occupy little space. The number of questions not contained in secondary school curricula is very limited. But with the aim of making the material quite clear, we considered many questions in greater detail than is usual practice in secondary school textbooks. It should also be noted that the exposition of the phenomena of atomic and nuclear physics deals with a greater circle of questions than is the rule in school instruction. When doing this, we followed the purpose of considering these questions with sufficient detail, with a view to students most interested in these topics. On the other hand, in these chapters it is difficult to explain all the problems dealt with quite consecutively, so that this part of the book has the nature of a textbook to a smaller extent than the remaining ones. We hope, however, that it will promote the appearance of serious interest in these most important problems of modern physics.

This volume is the last of the *Textbook of Elementary Physics* written by more than ten authors. This circumstance imposed a high

responsibility on the editor because, although the general principles underlying the textbooks are in full agreement, the approach of different authors to the various problems and methods of presenting them are inevitably different. Of course, this might affect the character of the presentation of the topics. However, the cooperation of many authors, each well versed in his own subject, undoubtedly offers a great advantage.

We hope, therefore, that despite the shortcomings, the textbooks will be helpful to all who are interested in physical problems.

G. Landsberg

PART ONE

OSCILLATIONS AND WAVES

CHAPTER 1
GENERAL. MECHANICAL OSCILLATIONS

1.1. Periodic Motion. Period. Among the various mechanical motions taking place around us, *recurring* motion is the most frequent. Any uniform rotation is a recurring motion: in each revolution, any point of a uniformly rotating body passes through the same positions as during the previous revolution, in the same sequence and with the same velocity. The same cycle of motions can be observed to be repeated when the wind swings the branches and trunks of trees, when a ship rides the waves, when the pendulum of a clock oscillates, when the pistons and connecting rods of steam and diesel engines, and the needle of a sewing machine reciprocate, when sea tides alternate, when one walks or runs, when a heart or a pulse beats.

Actually, the recurrence is not the same in all cases and conditions. Sometimes every new cycle exactly repeats the previous one (swinging of a pendulum, reciprocation of a machine running at a constant speed), sometimes cycles that follow one another may differ quite appreciably (tides, swinging of branches, motion of the parts of a machine being started or stopped). The deviation from true recurrence is sometimes so small that it can be neglected, and the motion may be considered to be repeated exactly, i. e., *periodic*.

A periodic motion is a recurring one in which every cycle exactly reproduces any other cycle.

The duration of one cycle is called a *period*.

Obviously, the period of uniform rotation is equal to the duration of one revolution.

1.2. Oscillatory Systems. Free Oscillations. In nature and especially in engineering we frequently encounter bodies and devices that can perform periodic motions by themselves without being compelled to do so by periodic external forces. Oscillations of this kind are called *free* to distinguish them from *forced* oscillations caused by the action of periodic external forces.

If, for example, a door is pushed or pulled, it will open or close, i.e., the door will be subjected to a periodic forced motion. But it will never move by itself. If a door is pushed and left alone it will never perform recurring motions. Matters are quite different if a weight hanging from a rope is deflected from the vertical. It will begin to