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R. A. HOUSTOUN

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PREFACE

THIS book is intended as a text-book for schools and for beginners generally. The work covered is approximately that required for the First Professional Examination in Medicine. A slight knowledge of trigonometry is assumed on the part of the student.

While there are many systematic books on the subject much larger than the present one, and also many elementary books on practical physics, there is no systematic treatment of the subject of exactly the same range. Consequently I hope the book may fill a want, especially since the report of the recent Royal Commission on the Position of Natural Science in the Educational System of Great Britain makes it probable that physics will in future be taught more from a systematic standpoint and less by the laboratory notebook method.

Mr. Alex. H. Gray, M.A., B.Sc., has read all the proof-sheets, and has worked all the examples. Some of the figures have been taken from Messrs. Longmans, Green and Co.'s other publications, and I am indebted to Messrs. Baird & Tatlock (London), Ltd., John J. Griffin & Sons, Ltd., and W. Butcher & Sons, Ltd., for the loan of trade blocks, but the greater number of the figures have been drawn specially for the book.

The book is the result of experience gained in assisting Prof. A. Gray, F.R.S., at Glasgow University, and I am indebted to Prof. Gray for many of the methods employed. Prof. James Muir, D.Sc., and Dr. G. E. Allan read part of the manuscript and the proofs, and I am indebted to them for many valuable suggestions.

R. A. HOUSTOUN.

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ELEMENTS OF PHYSICS

CHAPTER I

DYNAMICS

1. UNITS AND MEASUREMENT

PHYSICS is an exact science, and it deals with the relations between the measurements of different quantities. Now before we measure any quantity we must have a unit, in which to measure it. We must therefore begin our study of the subject by describing the units employed in it. They are of two kinds, fundamental units and derived units. The fundamental units are those of length, mass, and time; as examples of derived units we may take the unit of volume, which can be expressed in terms of the unit of length, or we may take the unit of velocity, which can be expressed in terms of the unit of length and the unit of time.

There are two systems of fundamental units established by law in this country, the foot-pound-second system, sometimes referred to as the British system, and the centimetre-gram-second system or metric system, which is usually referred to for short as the c.g.s. system.

The standard unit of length on the ft.-lb.-sec. system is the yard, which is defined by Act of Parliament as follows: "The straight line or distance between the centres of the transverse lines in the two gold plugs in the bronze bar deposited in the Office of the Exchequer shall be the genuine standard at 62° F., and if lost it shall be replaced by means of its copies." The foot is, of course, $\frac{1}{3}$ of the yard. The standard unit of mass on the ft.-lb.-sec. system is the pound; this is defined as the mass of a certain piece of platinum, marked "P.S., 1844, 1 lb.," which is kept at the same place as the standard yard.

The yard and pound are arbitrary units, that is, they are not intended to be the length or mass of any object existing in nature; they are the descendants of units employed in ancient times. The c.g.s. system, on the contrary, was a new system devised by a scientific committee appointed in France after the great revolution. The standard unit of length on this system, the metre, was based on the earth's dimensions, and was intended to be one ten-millionth part of the distance from the North Pole to the Equator measured along the meridian passing through Paris. A rod of platinum was made by Borda which should fulfil this condition at 0° C., and as it would be inconvenient to alter the standard of length slightly every time a more accurate determination of the length of the earth's meridian was made,