A COURSE OF EXERCISES IN ELEMENTARY PHYSICS

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649487806

A Course of Exercises in Elementary Physics by Harold Whiting

Edited by Trieste Publishing Pty Ltd.
Cover @ 2017

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Trieste

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IN

ELEMENTARY PHYSICS.

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PUBLISHED BY

THE BERKELEY PRESS,

Box 2122,

SAN FRANCISCO,

1894.

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HYDROSTATICS.

PRESSURE.

EXPANSION.

HEAT.

LIGHT.

*Comparatively elementary. **Suitable for Preparatory Schools.
†Difficult of explanation. ‡Difficult on practical grounds.

SOUND.

DYNAMICS.

MAGNETISM.

ELECTROMAGNETISM.

ELECTRICAL ENERGY.

MAGNETO-ELECTRIC INDUCTION.

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PREFACE.

This book consists in a collection of directions for some sixty or more exercises in elementary physics, which have been given during the current academic year (1893—1894) to students in the University of California. It is not expected that these directions, which were prepared under stress of work, will be free from faults or inconsistencies; but they have been found to yield, in most cases, sufficiently satisfactory results to warrant their issuance for another year; and it has been thought desirable to print them—this being, on the whole, the most economical method of distribution.

A secondary object in printing these directions has been to lay before the teachers of this State a proposed line of demarcation between High School and College work, and to invite discussion and criticism upon this subject. The exercises included in this book are not intended to represent an ideal course either in a university or in a high school; but rather a collection of exercises intermediate in grade between the work at present performed in high schools, and that aimed at in our University. The desirability of a complete understanding and accord as to the division of such work between School and College must be evident to every teacher of physics in this State.

Excellent suggestions as to the nature of a High School course in physics will be found in the report of two members of the "Committee of Ten" published by the United States Bureau of Education, 1893. At the same time,

serious faults seem to exist in this report. The introduction of "Wheatstone's bridge" (before the student has any adequate idea of the distribution of potential in an electric circuit) is certainly objectionable; as is also the study of the laws of motion at a point of time when the student can hardly be familiar with the mathematical expressions necessary to the understanding of acceleration. On the other hand, the author has shown that a determination of the "mechanical equivalent of heat" can be made by any student with considerable accuracy and at a nominal cost, as far as apparatus is concerned. Other methods of reaching the same end can doubtless be devised by any teacher having a moderate degree of ingenuity. Under the circumstances, the inclusion of this fundamental and highly instructive experiment in any extended high school course would seem to be desirable. Several other criticisms upon the course suggested by the "Committee of Ten" might be made here; but it is thought that the author's opinions on this subject are sufficiently exemplified by the list of exercises included in this book.

In the Table of Contents, exercises which contain parts suitable (in the author's opinion) for a high school course are marked with an asterisk (*), and those which might perhaps be adopted without essential modification are marked with two asterisks. Exercises, however, involving theoretical difficulties, which cannot be explained satisfactorily to beginners, are distinguished by a dagger (†); and those offering experimental obstacles, too great to be overcome in the teaching of large classes, are distinguished by a double dagger (‡).

The exercises have been found to occupy each from two to three hours of a student's time. It is hoped that the majority of those in the first half of the list which are doubly starred may eventually find a place in the best high schools, without prejudice to the simpler experiments now taught there. In order that a place may be found for them, it is suggested that certain other experiments which have been found to offer practical or theoretical difficulties

even to more advanced students should be omitted. The first half of the exercises included in this book, covering hydrostatics, heat, light, and sound, would according to this scheme fall largely to the High School, while the laws of motion, and electrical or magnetic measurements in general, would constitute a more advanced course, taught only in the University, or in schools preparing students for advanced standing.

It is not suggested that experiments in electricity and magnetism should be excluded altogether from the High School, but that the work in these branches should be confined to fundamental phenomena, and that these even should not be studied to the prejudice of other branches of physics, a thorough knowledge of which is necessary for the subsequent understanding of the phenomena in question.

Teachers who wish to introduce exercises like those here outlined into school work should arrange, if possible, to have at least two successive school hours for their laboratory sections. Each student should be assigned to a given desk (in general) for a given day, only. He should find on this desk all the apparatus which he needs (or the materials for constructing it), together with notes or directions supplementing, when necessary, the laboratory manual. He should be required to leave his desk as he found it, so as to be ready for the student next behind him in order.

The apparatus, if there is not a complete set for each member of a given section, should be set up for different experiments on different desks, in so far as may be practicable, in progressive order, so that a whole section of students may be moved, at the proper time, each from one desk to the next, without discontinuity, in the case of any student, in the course of experiments followed. Students working more slowly than others should be allowed more time for each exercise, or required to make up, out of hours, for what they have lost, so as to be ready to go on with their work without losing their regular places in their