PHYSICAL MEASUREMENTS IN SOUND, LIGHT, ELECTRICITY AND MAGNETISM

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649671014

Physical Measurements in Sound, Light, Electricity and Magnetism by Thomas C. McKay

Edited by Trieste Publishing Pty Ltd.
Cover @ 2017

www.triestepublishing.com

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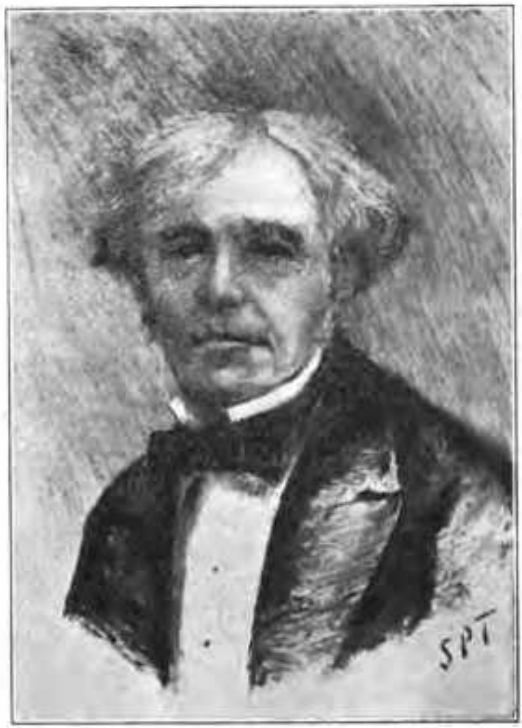
Trieste



MICHAEL FARADAY

PHYSICAL MEASUREMENTS

IN

SOUND, LIGHT, ELECTRICITY AND MAGNETISM

BY

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BERKELEY
1908

INTRODUCTION

This book is primarily intended as a text-book in physical measurements and a laboratory manual for second year students in physics at the University of California. At this institution there is offered to first year students a laboratory course in mechanics, properties of matter, and heat. The subjects considered in this book are therefore Sound, Light, Electricity, and Magnetism. The experiments here described have been chosen for the most part because they have proved to be valuable exercises in elementary laboratory courses given by instructors in physics at the University of California. A number of the experiments in this book have been described by Professor Drew, now of Leland Stanford University. Professor Hall of the University of California and Professor Minor of the University of Nevada have also contributed greatly to the development of the course. The writer has drawn upon several years experience at the University of California, as well as upon his previous experience at Harvard University, in the endeavor to select the most valuable experiments for an elementary laboratory course in the subjects of which this book treats. As compared with the books issued by the writer's predecessors the sections on Electricity and on Sound have been enlarged. In the treatment of the subject of Electrostatics the writer is indebted to Professor Noack for his careful descriptions in his *"Elementare Messungen aus der Electrostatik."* Considerable use has also been made of Poynting and Thomson's *"Sound."* A description of the principal types of sensitive galvanometers has been given in the section on Electricity, with a short discussion of the conditions of greatest sensitiveness for these instruments.

It is recommended as the result of the experience of various instructors (in the course for which this book was written) that students should perform the experiments individually rather than in groups. If in large sections (and particularly in experiments that require a large number of measurements) it be necessary that some should work in pairs, care should be taken that each student familiarize himself with each kind of measurement involved. Calculations can in general be best performed during the laboratory period. It is easier to make the calculations with the apparatus set up. Frequently too it will be found that one requires some important datum that has not been noted, or that some essential observation is obviously faulty. It is desirable to plot the results of observations wherever possible. For this purpose as well as for the arithmetical calculations notebooks with cross-ruled paper are very convenient.

While nearly all the numbered exercises in the book require the measurement of some physical quantity, there is still opportunity for the student to do some qualitative work. In the exercise on the Wheatstone bridge, for example, there are provided a sensitive galvanometer, a resistance box, a mounted bridge wire, and some specimens whose resistance is to be tested. To see how the result of the measurement may be affected by various conditions one may place the finger on the junction of two dissimilar metals included in the bridge and notice the effect on the galvanometer when the latter is connected in the usual position. He may try likewise the effect of warming a portion of the bridge wire or again the effect of introducing self-induction into one of the arms of the bridge. As the result of such an investigation it is probable that the reasons for the ordinary precautions in the comparison of resistances would become clear. The construction of the galvanometer and of the

resistance box are also fair subjects of enquiry if pursued with due regard to the future usefulness of the instrument. The writer has made many suggestions regarding the care of the more valuable pieces of apparatus. It is hoped that the student will read these carefully before working with such apparatus. It is the writer's custom to assign experiments several days in advance so that it is possible for the student to prepare himself by reading in advance.

If the student is to get the best results from a laboratory course it is well to exercise great care in drawing conclusions. The most valuable part of an exercise usually consists in the thorough understanding of the reasons for the various precautions that are necessary for a good measurement. In his text-book on physics for secondary schools Professor Slate has shown that critical studies of great value may be made in very elementary laboratories. Precautions that have been taken in securing any result should be recorded in the notebook. In some cases it may be easy to form an estimate of the possible percentage error in the result of a measurement.

The writer is in the habit of giving an opportunity for special work to students who may become interested in any special problem after they have performed in a satisfactory manner the most fundamental experiments in the course. Such students are furnished with the necessary apparatus so far as the resources of the laboratory permit.

The writer is indebted for suggestions made by Professor E. E. Hall, who kindly looked over the manuscript. Mr. Harold Edwards has suggested improvements in some of the apparatus and has typewritten some of the manuscript. The writer has received much assistance from his wife in the preparation of the drawings from which the cuts have been made.

THOMAS C. MCKAY.

Berkeley, August, 1908.