ELEMENTS OF PHYSICAL MANIPULATION; PP. 1-221

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649572120

Elements of Physical Manipulation; pp. 1-221 by Edward C. Pickering

Edited by Trieste Publishing Pty Ltd.
Cover @ 2017

www.triestepublishing.com

EDWARD C. PICKERING

ELEMENTS OF PHYSICAL MANIPULATION; PP. 1-221

Trieste

Charles K Wead.
Sept. 25th 1873.

ELEMENTS

OF

PHYSICAL MANIPULATION.

BY
EDWARD C. PICKERING,
Thayer Professor of Physics in the Massachusetts Institute of Technology

NEW YORK:
PUBLISHED BY HURD AND HOUGHTON.
Cambridge: The Riverside Press.
1873.

TO

Prof. Wm. B. Rogers,

THE FIRST TO PROPOSE A PHYSICAL LABORATORY,

THIS WORK IS MOST AFFECTIONATELY INSCRIBED

BY HIS

SINCERE FRIEND AND PUPIL,

THE AUTHOR.

PREFACE.

THE rapid spread of the Laboratory System of teaching Physics, both in this country and abroad, seems to render imperative the demand for a special text-book, to be used by the student. To meet this want the present work has been prepared, based on the experience gained in the Massachusetts Institute of Technology during the past four years. The preliminary chapter is devoted to general methods of investigation, and the more common applications of the mathematics to the discussion of results. The graphical method does not seem to have attracted the attention it deserves; it is accordingly compared here with the analytical method. Some new developments of it are moreover inserted. It is of fundamental importance that the student should clearly understand how to deal with his observations, and reduce them, and that he should be familiar with the various kinds of errors present in all physical experiments. A short description is also given of the various methods of measuring distances, time and weights, which, in fact, form the basis of all physical investigation. This chapter is intended as the ground-work of a short course of lectures, given to the students before they begin their work in the laboratory. It should be so far extended by the instructor, as to render them familiar with the general principles on which all physical instruments are constructed, thus greatly

aiding them when they have occasion to devise apparatus for their own work.

The remainder of the volume is devoted to a series of experiments which it is intended that the student shall perform in the laboratory. Each experiment is divided into two parts; the first called *Apparatus*, giving a description of the instruments required, and designed to aid the instructor in preparing the laboratory for the class. The student should read this over, and with it the second part, entitled *Experiment*, which explains in detail what he is to do.

Perhaps the greatest advantage to be derived from a course of physical manipulation, is the means it affords of teaching a student to think for himself. This should be encouraged by allowing him to carry out any ideas that may occur to him, and so far as possible devise and construct, with his own hands, the apparatus needed. Many such investigations are suggested in connection with some of the experiments, for instance Nos. 13, 37, 48, 69, 77, 93 and others. To aid in this work, a room adjoining the laboratory should be fitted up with a lathe and tools for working in metals and wood, as most excellent results may sometimes be attained at very small expense, by apparatus thus constructed by students.

The method of conducting a Physical Laboratory, for which this book is especially designed, and which has been in daily use with entire success at the Institute, is as follows. Each experiment is assigned to a table, on which the necessary apparatus is kept, and where it is always used. A board called an indicator is hung on the wall of the room, and carries two sets of cards opposite each other, one bearing the names of the experiments, the other those of the students. When the class enters the laboratory, each member goes to the indicator, sees what experiment is assigned to him, then to the proper table where he finds the instruments required, and by the aid of the book performs the experiment.

Any additional directions needed are written on a card also placed on the table. As soon as the experiment is completed, he reports the results to the instructor, who furnishes him with a piece of paper divided into squares if a curve is to be constructed, or with a blank to be filled out, when single measurements only have been taken. In either case a blank form is supplied, as a copy. New work is then assigned to him by merely moving his card opposite any unoccupied experiment. By following this plan an instructor can readily superintend classes of about twenty at a time, and is free to pass continually from one to another, answering questions and seeing that no mistakes are made. He can also select such experiments as are suited to the requirements or ability of each student, the order in which they are performed being of little importance, as the class is supposed to have previously attained a moderate familiarity with the general principles of physics. Moreover, the apparatus never being moved, the danger of injury or breakage is thus greatly lessened and much time is saved. To avoid delay, the number of experiments ready at any time should be greater than that of the students, and the easier ones should be gradually replaced by those of greater difficulty.

Among these experiments several novelties, here published for the first time, have been introduced. For instance, the apparatus for ruling scales, p. 59, the photometers, pp. 132 and 134, and the polarimeter, p. 221. It is also believed that the directions for weighing, p. 47, and the adjustments for the optical circle, p. 142, if not new, at least present the subject in a more concise and practical form than that commonly given. In fact it has been the object throughout to give definite directions, so far as possible, as if addressing the student in person. English weights and measures are occasionally used as well as French to familiarize the student with both systems, as in many of the practical applications of physics the general prevalence of the foot and pound as units seems