

**ELEMENTARY
MECHANICS, INCLUDING
HYDROSTATICS AND
PNEUMATICS**

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Elementary Mechanics, Including Hydrostatics and Pneumatics by Oliver J. Lodge

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OLIVER J. LODGE

**ELEMENTARY
MECHANICS, INCLUDING
HYDROSTATICS AND
PNEUMATICS**

CHAMBERS'S
ELEMENTARY SCIENCE MANUALS

ELEMENTARY MECHANICS

INCLUDING

HYDROSTATICS AND PNEUMATICS

BY

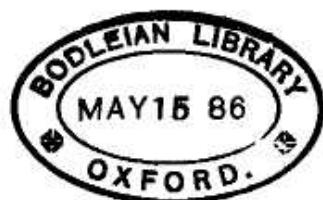
OLIVER J. LODGE, D.SC. LOND.

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LIVERPOOL.

Revised Edition



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GENERAL PLAN OF THE SERIES.

THE subjects of these Manuals are for the most part, though not exclusively, the same as those of the Syllabus of the Science and Art Department, South Kensington, and the treatment will be found to meet the requirements for the Examinations held by that Department.

In their wider scope the Manuals are intended to serve two somewhat different purposes :

1. They are designed, in the first place, for SELF-INSTRUCTION, and will present, in a form suitable for private study, the main subjects entering into an enlightened education ; so that young persons in earnest about self-culture may be able to master them for themselves.

2. The other purpose of the Manuals is to serve as TEXT-BOOKS IN SCHOOLS. The mode of treatment naturally adopted in what is to be studied without a teacher, so far from being a drawback in a school-manual, will, it is believed, be a positive advantage. The subject is made, as far as possible, to unfold itself gradually, as if the pupil were discovering the principles himself, the chief function of the book being, to bring the materials before him, and to guide him by the shortest road to the discovery. This is now acknowledged to be the only profitable method of acquiring knowledge, whether as regards self-instruction or learning at school.

PREFACE.

THE non-mathematical English works on Mechanics are mainly of two kinds—one the old-fashioned text-book, which every one now feels to be quite unsatisfactory; and the other, the comprehensive and powerful productions of Professors Thomson and Tait, Clerk Maxwell, and W. K. Clifford; which, though not confessedly mathematical, are yet far too difficult for ordinary beginners.

The present book aims at giving a clear knowledge of the principles of the subject, in as elementary and even popular a manner as is consistent with careful accuracy, and without assuming any mathematical knowledge beyond the most rudimentary algebra. At the same time it is hoped that students who use this manual will be able to master the elements of the science in such a way that they may rise from it to more advanced treatises, not only without having anything to unlearn, but with a very sound knowledge of principles. Copious illustrations and explanations have been all along inserted, and the general plan of the Series, of which this forms a volume, has been kept steadily in view.

The examples at the end of the chapters are typical ones, and are intended not only to be worked without looking at the answers, but also to be read almost as part of the book, because they frequently direct attention to important details. The solving of a few miscellaneous exercises such as those at the end of the book, is good practice, but it has not been thought well to fill up the book with a host of numerical questions which are often mere exercises in arithmetic; the time spent in solving such would often be more usefully employed in reading and thinking over fundamental principles.

The statements made in a book should be carefully criticised and not taken for granted—and all kinds of special cases should be thought of or tried, to see if an exception cannot be found. *It is by thinking one's-self on a subject that it becomes really known to one's-self; it will*

never be really known if we only try to understand and remember what the book says. Any emendation or correction of statements in the following pages will be gratefully received.

The author has as a matter of course to acknowledge obligations to Thomson and Tait's *Natural Philosophy*, and to Professor Clerk Maxwell's little manual, *Matter and Motion*. To Deschanel (Part I.—obtainable separately) and Ganot (Books I.—IV.) such frequent reference has been made, that they need only be mentioned here in order to recommend real students to read one or other of them along with the present work, so as to fill up their knowledge in more detail. They may also be referred to Professor Garnett's *Elementary Dynamics* for a rather more mathematical treatment of certain subjects, and for numerous problems and exercises.

The author has to thank Dr Henrici for his kindness in revising the proofs of Chapters VII. and VIII., and for several valuable suggestions. His obligations to Professor Carey Foster are so great, that it is as impossible as it is unnecessary to express them. It is while he has been under Mr Foster's influence that he has learned everything of any accuracy that he knows on the subject, and more than half the book may be traced to his teaching, direct or indirect.

OLIVER J. LODGE.

SUGGESTIONS FOR READING.

Beginners are recommended to omit the following sections on a first reading: 15-17, 37-40, 50-52, 56, 57, 82, 83, 95, 104, 111, 112, 141-143, 147-150, 179; and then to return and read the omitted portions together, and finally to read the whole book through carefully without omitting anything. Students preparing only for London University matriculation, or for the elementary stage of the Science and Art Department, may pretty safely omit any of the above sections over which they experience much difficulty, until the examination is over.

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