CAMBRIDGE LIBRARY COLLECTION

Books of enduring scholarly value

Mathematical Sciences

From its pre-historic roots in simple counting to the algorithms powering modern desktop computers, from the genius of Archimedes to the genius of Einstein, advances in mathematical understanding and numerical techniques have been directly responsible for creating the modern world as we know it. This series will provide a library of the most influential publications and writers on mathematics in its broadest sense. As such, it will show not only the deep roots from which modern science and technology have grown, but also the astonishing breadth of application of mathematical techniques in the humanities and social sciences, and in everyday life.

Elements of the Mathematical Theory of Electricity and Magnetism

The British physicist Sir Joseph John Thomson published the first edition of his Elements of the Mathematical Theory of Electricity and Magnetism in 1895 and this fourth edition in 1909, three years after he was awarded the Nobel Prize in Physics for his theoretical and experimental investigations on the conduction of electricity by gases. In this book for students his intention is to give 'an account of the fundamental principles of the Mathematical theory of Electricity and Magnetism and their more important applications, using only simple mathematics'.

Elements of the Mathematical Theory of Electricity and Magnetism

John Joseph Thomson

CAMBRIDGE
UNIVERSITY PRESS

CAMBRIDGE UNIVERSITY PRESS

Cambridge New York Melbourne Madrid Cape Town Singapore São Paolo Delhi

Published in the United States of America by Cambridge University Press, New York

www.cambridge.org
Information on this title: www.cambridge.org/9781108004909

This edition first published 1909
This digitally printed version 2009

ISBN 978-1-108-00490-9

ELEMENTS

OF THE

MATHEMATICAL THEORY

OF

ELECTRICITY AND MAGNETISM

CAMBRIDGE UNIVERSITY PRESS
London: FETTER LANE, E.C.
C. F. CLAY, MANAGER

Edinburgh: 100, PRINCES STREET
Berlin: A. ASHER AND CO.
Leipzig: F. A. BROCKHAUS
New York: G. P. PUTNAM'S SONS
Bombay and Calcutta: MACMILLAN AND CO., LTD.

ELEMENTS

OF THE

MATHEMATICAL THEORY

OF

ELECTRICITY AND MAGNETISM

BY

SIR J. J. THOMSON, M.A., D.Sc., LL.D., PH.D., F.R.S.,

FELLOW OF TRINITY COLLEGE, CAMBRIDGE;
CAVENDISH PROFESSOR OF EXPERIMENTAL PHYSICS IN THE UNIVERSITY OF CAMBRIDGE;
PROFESSOR OF NATURAL PHILOSOPHY IN THE ROYAL INSTITUTION, LONDON

FOURTH EDITION

CAMBRIDGE:
AT THE UNIVERSITY PRESS
1909

First Edition 1895.
Second Edition 1897.
Third Edition 1904.
Fourth Edition 1909.

PREFACE TO FIRST EDITION

In the following work I have endeavoured to give an account of the fundamental principles of the Mathematical theory of Electricity and Magnetism and their more important applications, using only simple mathematics. With the exception of a few paragraphs no more advanced mathematical knowledge is required from the reader than an acquaintance with the Elementary principles of the Differential Calculus.

It is not at all necessary to make use of advanced analysis to establish the existence of some of the most important electromagnetic phenomena. There are always some cases which will yield to very simple mathematical treatment and yet which establish and illustrate the physical phenomena as well as the solution by the most elaborate analysis of the most general cases which could be given.

The study of these simple cases would, I think, often be of advantage even to students whose mathematical attainments are sufficient to enable them to follow the solution of the more general cases. For in these simple cases the absence of analytical difficulties allows attention to be more easily concentrated on the physical aspects of the question, and thus gives the student a more vivid

idea and a more manageable grasp of the subject than he would be likely to attain if he merely regarded electrical phenomena through a cloud of analytical symbols.

I have received many valuable suggestions and much help in the preparation of this book from my friends Mr H. F. Newall of Trinity College and Mr G. F. C. Searle of Peterhouse who have been kind enough to read the proofs. I have also to thank Mr W. Hayles of the Cavendish Laboratory who has prepared many of the illustrations.

J. J. THOMSON.

CAVENDISH LABORATORY,
CAMBRIDGE.
September 3, 1895.

PREFACE TO THE SECOND EDITION

IN this Edition I have through the kindness of several correspondents been able to correct a considerable number of misprints. I have also made a few verbal alterations in the hope of making the argument clearer in places where experience has shown that students found unusual difficulties.

J. J. THOMSON.

CAVENDISH LABORATORY,
CAMBRIDGE.
November, 1897.

PREFACE TO THE THIRD EDITION

THE most important of the alterations made in this Edition is a new chapter on the properties of moving electrified bodies; many of these properties may be proved in a simple way, and the important part played by moving charges in Modern Physics seems to warrant a discussion of their properties in even an Elementary Treatise.

I have much pleasure in thanking Mr G. F. C. Searle of Peterhouse for many valuable suggestions, and for his kindness in reading the proof sheets of the first five chapters; to Mr P. V. Bevan of Trinity College I am indebted for similar assistance with the subsequent chapters.

J. J. THOMSON.

CAVENDISH LABORATORY,
CAMBRIDGE.
October 4, 1904.

PREFACE TO THE FOURTH EDITION

IN this Edition a few additions and corrections have been made.

J. J. THOMSON.

CAVENDISH LABORATORY,
CAMBRIDGE.
April 26, 1909.

TABLE OF CONTENTS