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.

Dynamics

Sir Horace Lamb (1849–1934) the British mathematician, wrote a number of influential works in classical physics. A pupil of Stokes and Clerk Maxwell, he taught for ten years as the first professor of mathematics at the University of Adelaide before returning to Britain to take up the post of professor of physics at the Victoria University of Manchester (where he had first studied mathematics at Owens College). As a teacher and writer his stated aim was clarity: 'somehow to make these dry bones live'. His Dynamics was first published in 1914 and the second edition, offered here, in 1923: it remained in print until the 1960s. It was intended as a sequel to his Statics (also reissued in this series), and like its predecessor is a textbook with examples.

Dynamics

HORACE LAMB

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/9781108005333

This edition first published 1961
This digitally printed version 2009

ISBN 978-1-108-00533-3

DYNAMICS

DYNAMICS

By

HORACE LAMB

CAMBRIDGE

AT THE UNIVERSITY PRESS
1961

PUBLISHED BY
THE SYNDICS OF THE CAMBRIDGE UNIVERSITY PRESS
Bentley House, 200 Euston Road, London, N.W.1
American Branch: 32 East 57th Street, New York 22, N.Y.
West African Office: P.O. Box 33, Ibadan, Nigeria

First edition 1914
Reprinted 1920
Second edition 1923
Reprinted 1926
1929
1942
1945
1946
1947
1951
1960
1961

Printed in Great Britain at the University Press, Cambridge
(*Brooke Crutchley, University Printer*)

PREFACE

THIS book is a sequel to a treatise on Statics published a little more than a year ago, and has a similar scope. To avoid repetitions, numerous references to the former volume are made.

A writer who undertakes to explain the elements of Dynamics has the choice, either to follow one or other of the traditional methods which, however effectual from a practical point of view, are open to criticism on logical grounds, or else to adopt a treatment so abstract that it is likely to bewilder rather than to assist the student who looks to learn something about the behaviour of actual bodies which he can see and handle. There is no doubt as to which is the proper course in a work like the present; and I have not hesitated to follow the method adopted by Maxwell, in his *Matter and Motion*, which forms, I think, the best elementary introduction to the 'absolute' system of Dynamics. Some account of the more abstract, if more logical, way of looking at dynamical questions is, however, given in its proper place, which is at the end, rather than at the beginning of the book.

There is some latitude of judgment as to the order in which the different parts of the subject should be taken. To many students it is more important that they should gain, as soon as possible, some power of dealing with the simpler questions of 'rigid' Dynamics, than that they should master the more intricate problems of 'central forces,' or of motion under various laws of resistance. This consideration has dictated the arrangement here adopted, but as the later chapters are largely independent of one another, they may be read in a different order without inconvenience.

Some pains have been taken in the matter of examples for practice. The standard collections, and the text-books of several generations, supply at first sight abundant material for appropriation, but they do not always reward the search for problems which are really exercises on dynamical theory, and not merely algebraical or trigonometrical puzzles in disguise. In the present treatise, preference has been given to examples which are simple rather than elaborate from the analytical point of view. Most of those which are in any degree original have been framed with this intention.

I am again greatly indebted to Prof. F. S. Carey, and Mr J. H. C. Searle, for their kindness in reading the proofs, and for various useful suggestions. The latter has moreover verified most of the examples. Miss Mary Taylor has also given kind assistance in the later stages of the passage through the press.

H. L.

THE UNIVERSITY,
MANCHESTER.
January 1914.

In this issue a few pages have been re-written, and a number of errors have been corrected, chiefly in the examples. An additional set of miscellaneous exercises has also been inserted near the end. It will be understood that the 'Appendix,' which remains unaltered, is intended merely as a summary of the 'Newtonian' standpoint, from which an elementary text-book is necessarily written.

H. L.

CAMBRIDGE.
February, 1923.

CONTENTS

CHAPTER I.

KINEMATICS OF RECTILINEAR MOTION.

CHAPTER II.

DYNAMICS OF RECTILINEAR MOTION.

CHAPTER III.

TWO-DIMENSIONAL KINEMATICS.

CHAPTER IV.

DYNAMICS OF A PARTICLE IN TWO DIMENSIONS. CARTESIAN COORDINATES.

CHAPTER V.

TANGENTIAL AND NORMAL ACCELERATIONS. CONSTRAINED MOTION.

CHAPTER VI.

MOTION OF A PAIR OF PARTICLES.

CHAPTER VII.

DYNAMICS OF A SYSTEM OF PARTICLES.

CHAPTER VIII.

DYNAMICS OF RIGID BODIES.

ROTATION ABOUT A FIXED AXIS.

CHAPTER IX.

DYNAMICS OF RIGID BODIES (CONTINUED). MOTION IN TWO DIMENSIONS.

CHAPTER X.

LAW OF GRAVITATION.

CHAPTER XI.

CENTRAL FORCES.

CHAPTER XII.

DISSIPATIVE FORCES.

CHAPTER XIII.

SYSTEMS OF TWO DEGREES OF FREEDOM.

APPENDIX.