

**DYNAMICS OF ROTATION:  
AN ELEMENTARY  
INTRODUCTION TO RIGID  
DYNAMICS**

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649108800

Dynamics of rotation: an elementary introduction to rigid dynamics by A. M. Worthington

Except for use in any review, the reproduction or utilisation of this work in whole or in part in any form by any electronic, mechanical or other means, now known or hereafter invented, including xerography, photocopying and recording, or in any information storage or retrieval system, is forbidden without the permission of the publisher, Trieste Publishing Pty Ltd, PO Box 1576 Collingwood, Victoria 3066 Australia.

All rights reserved.

Edited by Trieste Publishing Pty Ltd.  
Cover @ 2017

This book is sold subject to the condition that it shall not, by way of trade or otherwise, be lent, re-sold, hired out, or otherwise circulated without the publisher's prior consent in any form or binding or cover other than that in which it is published and without a similar condition including this condition being imposed on the subsequent purchaser.

[www.triestepublishing.com](http://www.triestepublishing.com)

**A. M. WORTHINGTON**

**DYNAMICS OF ROTATION:  
AN ELEMENTARY  
INTRODUCTION TO RIGID  
DYNAMICS**



# DYNAMICS OF ROTATION

AN ELEMENTARY INTRODUCTION  
TO RIGID DYNAMICS

BY

A. M. WORTHINGTON, C.B., M.A., F.R.S.

FORMERLY HEADMASTER AND PROFESSOR OF PHYSICS AT THE  
ROYAL NAVAL ENGINEERING COLLEGE, DEVONPORT


UNIV. OF CALIFORNIA  
*NEW IMPRESSION*  
UNIVERSITY LIBRARY

44345

LONGMANS, GREEN, AND CO.

39 PATERNOSTER ROW, LONDON  
FOURTH AVENUE & 30TH STREET, NEW YORK  
BOMBAY, CALCUTTA, AND MADRAS

1920



Digitized by the Internet Archive  
in 2007 with funding from  
Microsoft Corporation

<http://www.archive.org/details/dynamicsofrotati00wortiala>

## PREFACE TO THE FIRST EDITION

MANY students of Physics or Engineering, who from want either of mathematical aptitude, or of sufficient training in the methods of analytical solid geometry, are unable to follow the works of mathematical writers on Rigid Dynamics, must have felt disappointed, after mastering so much of the Dynamics of a Particle as is given in the excellent and widely-used text-books of Loney, or Garnett, or Lock, to find that they have been obliged, after all, to stop short of the point at which their knowledge could be of appreciable practical use to them, and that the explanation of any of the phenomena exhibited by rotating or oscillating rigid bodies, so interesting and obviously important, was still beyond their reach.

The aim of this little book is to help such students to make the most of what they have already learnt, and to carry their instruction to the point of practical utility.

As a matter of fact, any one who is interested and observant in mechanical matters, and who has mastered the relations between force, mass, and acceleration of velocity of translation, will find no difficulty in apprehending the corresponding relations between couples, moments of inertia, and angular accelerations, in a rigid

body rotating about a fixed axle, or in understanding the principle of the Conservation of Angular Momentum.

Instead of following the usual course of first developing the laws of the subject as mathematical consequences of D'Alembert's Principle, or the extended interpretation of Newton's Second and Third Laws of Motion, and then appealing to the experimental phenomena for verification, I have adopted the opposite plan, and have endeavoured, by reference to the simplest experiments that I could think of, to secure that the student shall at each point gain his *first* ideas of the dynamical relations from the phenomena themselves, rather than from mathematical expressions, being myself convinced, not only that this is the best way of bringing the subject vividly and without vagueness before the learner, but that such a course may be strongly defended on other grounds.

These considerations have determined the arrangement of the chapters and the limitations of the work, which makes no pretence at being a complete or advanced treatise.

My best thanks are due to those friends and pupils who have assisted me in the revision of the proof-sheets and in the working of examples, but especially to my colleague, Mr. W. Larden, for very many valuable suggestions and corrections.

A. M. W.

DEVONPORT, 31st Oct. 1891.



## PREFACE TO THE SIXTH EDITION

THE demand for successive editions of this book has afforded opportunities for considerable improvements since its first issue. Errors and omissions kindly pointed out by readers and friendly critics have been rectified, while the continued use of the book as a text-book with my own students has enabled me to detect and alter ambiguous phrases, and in some places to improve the arrangement of the argument.

The use of the Inertia-Skeleton, introduced on p. 64, has proved so satisfactory a simplification for non-mathematical students, to whom a momental ellipsoid would be only a stumbling-block, and could be used so readily for further extensions, in the manner indicated on pp. 122 and 123, that I hope I may be pardoned for calling attention to it.

Experiments with a gyroscope, made by the students themselves with Chapter XIII. as guide, have proved very satisfactory and interesting, and may usefully include a deduction of the rate of spin from an observation of the rate of precession, after the moment of inertia of the wheel has been determined by means of the oscillating table figured on p. 80.

In the interests of clear teaching, the convention (which I am glad to see has been adopted in America) has been adhered to throughout, of using the word 'pound' when a force is meant, and 'lb.' when a mass is meant, and I have ventured to give the name of a 'slug' to the British Engineer's Unit of Mass, *i.e.* to the mass in which an acceleration of one foot-per-sec.-per-sec. is produced by a force of one pound.

A. M. W.

DEVONPORT, 11th June 1906.

# CONTENTS.

---

## CHAPTER I.

### DEFINITIONS OF TERMS AND PRELIMINARY KINEMATICS.

- Page 1. Rigid Body.
- „ 2. Angular Velocity.
  - „ 2. Rate of Revolution.
  - „ 3. Relation between ( $v$ ) and ( $\omega$ ).
  - „ 3. Angular Acceleration.
  - „ 3. Uniformly Accelerated Rotation.
  - „ 5. Examples.
  - „ 6. Geometrical Representation of Angular Velocities and Accelerations.
  - „ 7. On the Use of the word Moment.
  - „ 8. Definition of Torque.
  - „ 8. Definition of Equal Torques.
  - „ 8. Fundamental Statical Experiment.
  - „ 8. Measure of Torque.
  - „ 8. Unit Torque.
  - „ 9. British Absolute Unit of Torque.
  - „ 9. Gravitation or Engineer's British Unit of Torque.
  - „ 9. Distinction between 'pound' and 'lb.'

## CHAPTER II.

### ROTATION UNDER THE INFLUENCE OF TORQUE.

- Page 11. Proposition I.
- „ 12. Proposition II.
  - „ 13. Methods of Experimental Verification.