

INTRODUCTION TO THE SCIENCE OF DYNAMICS

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649115549

Introduction to the science of dynamics by D. H. Marshall

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

D. H. MARSHALL

**INTRODUCTION TO
THE SCIENCE OF
DYNAMICS**

TABLE OF CONTENTS.

	PAGE.
INTRODUCTION.....	1
Observation, experiment, space, matter, physics, C.G.S and F.P.S. units.	
CHAPTER I. Extension. Direction.....	5
Units of measurement, fundamental and derived ; direction, angle, radian; body, particle, molecule, atom.	
CHAPTER II. Motion. Velocity.....	12
Rest; relative, absolute; time, equal times; speed, tach, vel; angular motion.	
CHAPTER III. Acceleration.....	19
CHAPTER IV. Uniformly Accelerated Motion.....	25
CHAPTER V. Inertia. Mass.....	34
Centrifugal force; density, specific mass, specific volume.	
CHAPTER VI. Momentum. Force.....	43
Gramtach, poundvel; impulse; dyne, poundal; pressure, tension, attraction, repulsion, friction; dynamics, statics, kinetics, kinematics, mechanics.	
CHAPTER VII. Weight. Gravitation.....	52
Vertical, horizontal; absolute and gravitation units of force.	
CHAPTER VIII. Archimedes' Principle.....	62
Specific weights, hydrometer, specific gravity bottle.	
CHAPTER IX. Pascal's Principle. The Barometer..	70
Solid, fluid, liquid, gas, vapour; barad; Bramah press; hydrostatic paradox; Torricelli's experiment; suction-pump.	
CHAPTER X. Specific Weights of Gases.....	81
CHAPTER XI. Exact Specific Weights.....	90
Baroscope; dew-point, hygrometer.	

	PAGE.
CHAPTER XII. Work. Energy.....	99
Configuration; molar energy, molecular energy, kinetic energy, potential energy; erg, foot-poundal; dyntach, horsepower; coefficient of friction; efficiency of a machine.	
CHAPTER XIII. Action and Reaction.....	110
Problem of Atwood's machine; coefficient of restitution.	
CHAPTER XIV. Dimensional Equations.....	115
CHAPTER XV. Composition of Velocities.....	124
Relative velocity and acceleration.	
CHAPTER XVI. Composition of Forces, whose lines of action meet another.....	131
Rigid body, stereodynamics; resolution of velocities and forces; equilibrium.	
CHAPTER XVII. Motion and Equilibrium on an Inclined Plane.....	140
Angle of friction; lines of quickest and slowest descent.	
CHAPTER XVIII. Composition of Forces whose lines of action are parallel.....	148
Centre of any system of parallel forces.	
CHAPTER XIX. Couples. Moments.....	154
Complete triangle of forces; rotation about a fixed axis.	
CHAPTER XX. Centres of Weight and Mass.....	161
Stable, unstable, and neutral equilibrium; centroids.	
CHAPTER XXI. Simple Machines.....	172
Mechanical, static, and kinetic advantages; lever and fulcrum, wheel and axle, toothed wheels, pulley and rope, Chinese wheel, screw and nut, endless screw, wedge.	
MISCELLANEOUS EXAMPLES.....	184

PHYSICAL LAWS.

	ARTICLE.
Law of Impenetrability	2
Newton's First Dynamical Law.....	40
Conservation of Mass	51
Newton's Second Dynamical Law.....	55
Newton's Third Dynamical Law.....	58
Conservation of Momentum.....	59
Hooke's Law.....	66
Law of Universal Gravitation.....	69
Archimedes' Principle.....	72
Pascal's Principle.....	80
Boyle's Law of Gaseous Pressure.....	94
Avogadro's Law of Molecular Volumes of Gases.....	97
Charles' Law of Gaseous Expansion.....	101
Dalton's Law of Gaseous Pressure.....	103
Rankine's enunciation of Boyle's and Dalton's laws..	103
Transformation of Energy.....	119
Conservation of Energy.....	120
Dissipation or Degradation of Energy.....	121
Law of Friction	122
D'Alembert's Principle.....	126
Principle of Work.....	189

TABLES OF MEASUREMENTS.

	PAGE.
English and French units of measurement	3
Approximate values of π	4
Values of g at different latitudes	56
Value of G	58
Specific volumes of gases	83
Specific masses and specific weights of gases relatively to dry air and hydrogen	84
Densities and specific weights of solids, liquids, and gases	85
Regnault's maximum pressures of aqueous vapour, for dew-points from 0 to 29	93
Coefficients of friction	105
Coefficients of restitution	112
Length, Area, Volume, Angle, Mass, Density, Time. .	120
Speed, Momentum, Force, Pressure-intensity	121
Work and Energy, Activity	122

USEFUL AND IMPORTANT NUMBERS.

- $\pi = 3.14159265$, $\log \pi = 0.4971499$, 1 radian = $180^\circ/\pi = 57.3^\circ$.
 Mean value of $g = 980.5$ tachs per sec., or $32\frac{1}{6}$ vels per sec.
 Zero of the centigrade scale = 273° air thermometer scale,
 and $0^\circ\text{A} = -273^\circ\text{C}$.
 Mean sea-level atmospheric pressure = 76 cm. of mercury
 at 0° in the latitude of Paris = 14.7 lbs.-wt. per sq. in.
 = $10\frac{1}{2}$ tonnes-wt. per sq. metre = 1.014 megabarad.
 Earth's mean radius = 6470.9 kilometres = 3958.7 miles.
 Earth's mean density = 5.67, and mass = 6.14×10^{21} tonnes.

PREFACE.

The present text-book embraces Part I and the half of Part II of the author's Introduction to the Science of Dynamics, first printed in 1886, and contains as much of that work, as experience has shewn he is able to give to the two divisions of his pass class at the University, at the present stage of university education in Ontario. The present edition will, I trust, be found to be a great improvement on the last. It is, however, impossible to escape all errors, and any suggestions or corrections from students will be thankfully received.

The names *tach*, *gramtach*, and *dynamtach* have been retained for the C.G.S. units of speed, momentum, and activity, as no other names as good as these have yet been proposed. The Canadian ton of 2,000 lbs. has been used in preference to the awkward English ton. Surely to call 112 lbs. a hundred-weight is unworthy of a scientific nation. Let such absurdities disappear, like that foolish but fast fading notion, that a knowledge of the dead languages is necessary to a liberal education, or that equally absurd one, that a knowledge of Hebrew should form an essential part of the education of a modern preacher.

It is difficult and I think pedantic for an author to attempt to enumerate the books and authors to whom he is indebted, but I cannot refrain from at least thankfully acknowledging my gratitude to my old teacher and friend, Prof. Tait, of Edinburgh University, to whose clear exposition of the great fundamental facts and laws underlying the constitution of the universe, so many thousands of students are indebted; and also my indebtedness to my

friend and former colleague, Prof. R. H. Smith, of London, emeritus professor of engineering in Mason College, Birmingham, for his trenchant criticism of the methods of dealing with some of the difficult problems in that only sure foundation of the higher problems in all the sciences, the science of Dynamics.

The full Table of Contents, as well as the lists of the Tables of Measurement and Physical Laws expounded in the text, which precede this preface, will, I trust, make reference to the text sufficiently easy to the student.

D. H. MARSHALL.

Elmhurst, Kingston, Ont.

9. IV, 1898.

INTRODUCTION.

All our knowledge of the material world is derived from *experience*, which can be conveniently divided into *observation* and *experiment*. Astronomy is an example of a science in which all our knowledge is primarily derived from simple observation, whereas in the science of electricity all important advances have been made by the performance of experiments. Hence, whilst the history of astronomy stretches over more than two thousand years, that of electricity hardly extends over two hundred.

Observation consists in simply observing with the aid only of our senses what is taking place in the material world.

Experiment is the controlling to a greater or less extent what is to take place, in order to find out what will take place under special circumstances.

What we observe and experiment with is *matter*. This term, like the terms *space*, *direction*, and *time*, it is impossible to define satisfactorily.

Space is limitless extension in all directions. It is the abode of matter, in which all motions take place, though itself immaterial. The term *matter* is applied to anything which is perceived by our senses, and which occupies space. A shadow can be perceived but is not matter, since it does not occupy space. So with motion, perplexity, anger, joy. The *Torricellian vacuum* occupies space, but it is not matter, since (as yet) it cannot be perceived by the senses.