INTRODUCTION TO THE SCIENCE OF DYNAMICS

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D. H. MARSHALL

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Trieste

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USEFUL AND IMPORTANT NUMBERS.

$\pi = 3{\cdot}14159265$, $\log \pi = 0{\cdot}4971499$, 1 radian $= 180°/\pi = 57{\cdot}3°$.

Mean value of $g = 980{\cdot}5$ inchs per sec., or $32\frac{1}{6}$ vels per sec.

Zero of the centigrade scale $= 273°$ air thermometer scale, and $0°\text{A} = -273°\text{C}$.

Mean sea-level atmospheric pressure $= 76$ cm. of mercury at 0° in the latitude of Paris $= 14{\cdot}7$ lbs.-wt. per sq. in. $= 10\frac{1}{3}$ tonnes-wt. per sq. metre $= 1{\cdot}014$ megabarad.

Earth's mean radius $= 6{\cdot}4709$ kilometres $= 3958{\cdot}7$ miles.

Earth's mean density $= 5{\cdot}67$, and mass $= 6{\cdot}14 \times 10^{21}$ 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 *dyntach* 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.