ELEMENTARY EXPERIMENTAL DYNAMICS FOR SCHOOLS

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FOR SCHOOLS

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PREFACE

THIS book forms the second part of an introductory course of Mechanics for schoolboys. To add to the number of text-books on Dynamics calls for apology, or at least for an indication that the guiding principles differ to some extent from those usually followed; hence a brief statement of the point of view adopted may be advisable.

The ordinary deductive treatment of kinetics, starting from Newton's Laws as axioms, though satisfactory for mature minds, has proved ill-suited to young boys. Inductive methods appeal to them with much greater force, and it seems advisable that their attention should be concentrated at first on simple quantitative experiments and the development of the fundamental principles of mechanics from their results.

These principles involve ideas so difficult and so unfamiliar that it is highly inexpedient to develop them by means of mathematical processes which are too recently acquired to be instinctive. Even if practice in the application of such processes is the real object in teaching mechanics, the final result will be better if the mathematics used in the early stages is limited to arithmetic and very simple numerical trigonometry or geometry. Methods which are more explicitly mathematical may be introduced when the pupil has advanced some distance on these lines, and he will then be in a position to appreciate their generality and their advantages as labour-saving devices. At a later stage, of course, he can make no progress without the use of formal mathematics, but it is desirable that he should retain even then the habit of realising the mechanical meaning of each step in the manipulation of the symbols. To quote Thomson

and Tait, "Nothing can be more fatal to progress than a too confident reliance on mathematical symbols; for the student is only too apt to take the easier course, and consider the *formula* and not the *fact* as the physical reality."

This numerical work in no way saves a boy from the necessity of thinking; in fact, the refusal to supply him with formulae and standard methods forces him to trust to his own powers, and reveals to him, as well as to his teacher, any failure in comprehension. With this object, numerical examples have been interspersed throughout the text; questions involving descriptions have been kept separate in order that they may be combined as desired with the numerical questions. The introduction of more general methods is deferred almost to the end of the book, so that the master may be free to use them earlier with such pupils as are ready for them, without detriment to those who are slower.

The course is designed so that all the more important experiments can be performed by the master with very few pieces of apparatus in an ordinary mathematical class-room; but it is obviously preferable that the pupil should perform some at least of them. A few details of suitable apparatus are given in an appendix.

In order to instil concrete ideas of mass, work, energy, momentum, etc., many of the illustrations have been drawn from simple engineering practice. The modern boy is keenly interested in such machines as motor-bicycles and aeroplanes, and is sufficiently familiar with them on their qualitative side not to require elaborate descriptions of their mode of action; his sense of power is greatly increased when he finds that his study of mechanics enables him to get even approximate values for their performances. The policy of refusing to touch anything until it can be dealt with completely may commend itself to the cautious teacher, but it is very cramping to the growing mind; for example, it appears preferable to give a broad idea of the principles underlying the action of a screw propeller and a rough numerical

approximation to its behaviour under given conditions, rather than to wait until some future mathematician shall have discovered a method of solving the problems it presents. When the boy passes from the class-room to the larger world he will find that progress does not always wait until the theory is complete, and it is a good thing to accustom him early to use such knowledge as he possesses in obtaining the best results within his reach, and thus to realise the desirability of further knowledge to render these results more trustworthy. This principle has been widely adopted in the teaching of elementary pure mathematics, and there is every reason for extending it in the study of mechanics.

There is a large number of text-books on elementary Applied Mechanics, written for students of Engineering, which deal in this manner with real rather than academic problems, but many teachers feel that they pay so little attention to logical treatment that they are better adapted to technical instruction than to education; a serious effort has been made in this little book to maintain an adequate standard in this respect.

In the elementary treatment of a subject of such antiquity, plagiarism is inevitable and often unconscious, and its due acknowledgment in individual cases becomes impossible; but the author is under an especial debt of gratitude to his colleagues at the Royal Naval College, Dartmouth, for permission to draw largely on their experience, and on the store of examples which they have made for their own use; more particularly to Mr Portway, who has checked the answers to the examples. He also wishes to express his acknowledgment to the publishers of *Engineering* for permission to reproduce Figs. 73 and 78.

C. E. A.

DARTMOUTH,
March, 1913.