A TREATISE ON ELEMENTARY DYNAMICS

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A TREATISE ON
ELEMENTARY DYNAMICS

DEALING WITH RELATIVE MOTION
MAINLY IN TWO DIMENSIONS

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PREFACE.

It is hoped that this little treatise may be of use to Candidates for mathematical scholarships, and to others whose reading is not quite elementary. I have assumed on the part of the student a knowledge of Trigonometry up to the Solution of Triangles, and of the simpler parts of Analytical Geometry; I have made occasional reference to the notation of the Differential Calculus for the benefit of students who may be beginning that subject.

Chapter I. deals chiefly with matter which in one form or another will be familiar to the student; I have, therefore, confined it within the narrowest limits possible. Here, and throughout, I have used the bar, introduced by Maxwell in *Matter and Motion*, to distinguish vector quantities; thus $\bar{u}$ will denote the vector whose scalar magnitude is u; the bar, however, has been employed only when necessary to prevent ambiguity, or to indicate, without circumlocution, that direction must be taken into account; for many purposes the phrase 'a velocity u' is a sufficiently clear abbreviation for 'a velocity whose magnitude is u,' some definite direction being implied by the use of the word *velocity* instead of the word *speed*.

In Chapter II. I have endeavoured to arrange the ideas of Clifford's *Dynamic* (Vol. I.) for the use of ordinary students.

Chapter III. is an attempt to state in an elementary manner the views held by modern writers on the Laws of Motion. It is based mainly on Mach's *Science of Mechanics*

(*Die Mechanik in ihrer Entwickelung*), Clifford's *Dynamic* (Vol. II.), Karl Pearson's *Grammar of Science*, and Mr. W. H. Macaulay's article in the *Bulletin of the American Mathematical Society* (July, 1897); I have throughout verified my references to the *Principia* in Lord Kelvin's Reprint. My object has been to preserve as far as possible the familiar landmarks; this procedure, however, presents difficulties which I can hope at the best to have but partially overcome. I have, in the text, indicated my great indebtedness to Mr. Macaulay; but it seems proper here formally to dissociate him from any responsibility for the contents of this chapter, especially as I cannot be sure that he would regard my statement of the matter as satisfactory. The same remark applies to the section dealing with the Measurement of Time in Chapter I.; but in this section even more than elsewhere I have to assume the responsibility for whatever may be defective.

When my little book was still unfinished, Professor Love's far more able and elaborate work appeared. As I was writing for less advanced students, and, though with the same intention, on quite a different plan, I was the more encouraged to proceed. I have availed myself of Professor Love's work, so far as my ability has permitted me, to check here and there what I have written; I further owe something to it in my treatment of Reactions.

Chapter IV. deals more fully with Work and Energy than has hitherto been customary in elementary books; Dr. Hicks' *Elementary Dynamics*, to which I have once or twice had occasion to refer, is an exception in this respect.

Chapter V. treats the Theory of Dimensions in a simple, and I trust satisfactory, manner.

Chapters VI., VII., and VIII., dealing respectively with Impact, Projectiles, and the Simple Pendulum, are slighter than is usual in text books of this class; but they contain, I hope, all that is essential. Much of the matter sometimes given under these heads finds a place in earlier parts of the present book. The comparatively small bulk of these

chapters is due also to a feeling that more time is devoted, as a rule, to these problems than their intrinsic importance warrants.

For some years past I have been accustomed to show to my pupils the graphic methods which I have occasionally employed in this book; when I began to collect examination papers I speedily became convinced that these methods would be already familiar to many students.

In addition to the works mentioned above, I have from time to time referred to Maxwell's *Matter and Motion*, to Thomson and Tait's *Natural Philosophy*, to Routh's *Rigid Dynamics* (Part I.), to Besant's *Dynamics*, to Garnett's *Elementary Dynamics*, and to Lock's *Elementary Dynamics*.

In selecting examples I have looked through not only Cambridge examination papers, but through many set by examining bodies elsewhere; a few of the examples are my own. I have to thank the various college authorities who have either supplied me with papers or given me access to their libraries. In particular I must tender my acknowledgments to the authorities of University College, Gower Street, for copies of papers set by Professor Pearson, from which I obtained more than one valuable hint; the use of the convenient term *speed-acceleration* I ventured to adopt from these papers.

I trust that I have acknowledged all my manifold obligation to the work of others, or at least that any omission may be put down to oversight. I cannot close these remarks without a few words of gratitude to the friends who have helped me, especially to Mr. Arthur Berry, whose constant kindness alone has encouraged me to proceed; my obligation to him is greater than I can express; at the same time I ought to say that the calls on his leisure are so great that I did not feel it right to ask him to give more than the most cursory glance at the sheets, and I cannot but fear that there may be much in the little book which he might not approve. To my friend Mr. J. T. Little, of Bedford Grammar School, I owe thanks for his continuous care in