

page is given to the story Aeneas and Dido, as an offshoot of the isoperimetric property of the circle.

All in all, this is a fascinating collection, drawn from legends, philosophy, natural science, literature and art, illustrating mankind's search for perfection.

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CALCULUS FOR PHYSICS by Richard Dalven  
 McGraw-Hill, 1984, x+149pp. St £8.25

Cries of frustration emanating from both teachers and pupils have been heard with increasing frequency in introductory physics courses in recent years - inadequate mastery of elementary mathematics being the source of the anguish on both sides. Indeed, the pages of this Bulletin have not been immune from the consequences of this problem [1,2]. While considerable study of the situation on both sides of the Atlantic has isolated some of the causes of this worldwide problem, finding sensible remedies has proved more difficult.

The widespread nature of this very real problem, however, has spawned a growth industry of books, self-teaching aids, computer-aided-learning packages and similar patent medicines, all designed to help the student to overcome his/her difficulties prior to, or in parallel with, an introductory course in physics. The principal difficulty with these approaches is that they tend to assume that the student has infinite time at his/her disposal to undertake remedial study of the required mathematical techniques. Some "Mathematics for Introductory Physics" or "Calculus for the Scientist and Engineer" books exceed 1000 pages! Many of the self-pacing aids require long intensive sessions and lack suitable instructional material. The physics teacher who attempts to incorporate some revision of mathematical methods into the course, soon finds

himself teaching a course in mathematics only, and usually an inadequate one at that.

Here at last is a little book which manages to get the balance right for those students whose problems are principally due to an inadequate background in elementary calculus. The book is designed for students taking their first course in physics and who have already taken, or are taking concurrently, a course in differentiation and integration. In the Irish situation this book would be useful for students taking Leaving Certificate higher level courses in both physics and mathematics or for those taking a first year course in introductory physics at a third-level institution. Richard Dalven is an experienced lecturer in freshman physics at the University of California at Berkeley and he shows a great sympathy for the problems encountered by students at this level. No pretence is made that this book represents a course in mathematics; rather, this is a review of introductory calculus, particularly where it is applied in elementary physics courses. Throughout the book the student is referred to his/her course in calculus in a refreshingly direct and informal tone. ('I would suggest that you work through this material fairly slowly, using your calculus book to refresh your memory on the mathematical points').

In a mere 118 pages of text all the essential topics needed for an introductory physics course are reviewed. No attempt is made to teach physics *per se* and the applications taken from physics are confined to the very simple. An emphasis is placed, however, on the interpretation of the key concepts in differentiation and integration as they arise in physics at this level.

Physics teachers are often amazed at the resistance of some mathematics teachers to invoke examples from everyday experience as an aid to understanding. This waste of good pedagogical opportunity seems extraordinary to this reviewer who had the particular privilege to be introduced to calculus by the late Mr. Fred Holland. Thirty years on, I still vividly recall him racing up and down the classroom with the floor covered with chalk lines as he kept reducing the distance over which he timed himself. His use of his pupils' understanding of the idea of speed to communicate insight of the nature of a derivative was, like all his teaching, masterful.

Dr. Dalven's book comprises two main sections, *viz*, derivatives and differentials (Chapter 2) and sums and integrals (Chapter 3). These are preceded by a short chapter in which the ideas of variables, functions and graphs are reviewed. It seems to be precisely in the area of the essential concepts of variables and functional relationships that the point of view of the mathematician has diverged most strongly from the physicist in recent years. Surely teachers

of mathematics and physics should give some thought to why so many of our students fail to recognize in our respective approaches what must in the last resort be one and the same concepts. Dr. Dalven's viewpoint in these matters is unreservedly that of a physicist, although throughout the book his approach is as mathematically rigorous as is possible keeping his primary objectives in mind.

The presentation of differentiation is standard, workmanlike and full of insight. The usual interpretation in terms of graphs is given in a clear and precise way. Special attention is given to functions of time because of their central importance in physics and applications to the description of motion in one dimension are discussed in some detail.

Two short sections are devoted to differentials and it must be said that this reviewer has some considerable reservations about these. In the first place, one wonders if it is really necessary to introduce the idea of a differential at all at this level. The same material can just as well be presented as relationships between small but finite changes in physical quantities which, in any event, are what are measured in any physical situation. Avoidance of the concept of a differential altogether would also avoid the highly dubious implication that certain 'differentials' (e.g. the change in heat energy giving rise to an infinitesimal increase in the temperature of a thermodynamic system) are perfect differentials in the mathematical sense. A student reader might be best advised to skip over both sections on differentials (about ten pages in all).

It is the final chapter (integration) that should make this book most useful for a student taking a course in introductory physics. The idea of an integral is interpreted in two ways both of which arise naturally in physics. First of all the integral is presented as an 'antiderivative' and later it is introduced as a 'sum of infinitesimal elements'. The 'antiderivative' approach is the easiest and most natural way, at an elementary level, to determine the potential energy function corresponding to a given force field. On the other hand, if one wants to compute the magnetic field strength at a point due to the electric current in a particular circuit, the integral seen as a sum of infinitesimal elements is a more obvious approach to take.

The general presentation of the book is pleasant and easy to read in keeping with the low-key of unhysterical approach of the author in the text. The chapters are broken up into sections at the end of each of which there is a short set of exercises. Worked solutions to all these exercises are given in an appendix. Any student embarking on a third-level programme that includes a

course in physics could do a lot worse than to buy this book and work through it carefully.

Unfortunately, many students entering Irish third-level institutions to take courses including physics have deficiencies in their mathematical foundation of a more fundamental nature than those which Dr. Dalven sets out to remedy. There is not much point in worrying about calculus when the basic manipulative skills of elementary algebra, geometry and trigonometry are missing. All these topics are meant to be covered at a perfectly adequate level in the Intermediate Certificate programme. Why is it that such a large fraction of students who go on to take mathematics courses at Leaving Certificate and third level turn out to be totally lacking in such skills?

## References

- [1] O Murchu, N. and O'Sullivan, C., *Mathematical Horses for Elementary Physics Courses*, Irish Mathematical Society Newsletter, 6, Dec. 1982, 50-54.
- [2] *Report on the Basic Mathematical Skills Test of First Year Students at Cork R.T.C. in 1984*, Irish Mathematical Society Newsletter, 14, Sept. 1985, 33-43.

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