Physics for the IB Diploma

Fourth edition

K. A. Tsokos

CAMBRIDGE UNIVERSITY PRESS

CAMBRIDGE UNIVERSITY PRESS
Cambridge, New York, Melbourne, Madrid, Cape Town, Singapore, São Paulo

Cambridge University Press
The Edinburgh Building, Cambridge CB2 2RU, UK

www.cambridge.org
Information on this title: www.cambridge.org/9780521604055

First published by K.A. Tsokos 1998
Second edition 1999
Third edition 2001
Fourth edition published by Cambridge University Press 2005

Printed in the United Kingdom at the University Press, Cambridge

A catalogue record for this publication is available from the British Library

ISBN-13 978-0-521-60405-5 paperback
ISBN-10 0-521-60405-2 paperback

ACKNOWLEDGEMENTS
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For Alexios and Alkeos

Preface

Physics is a fundamental science and those who study it will gain an understanding of the basic laws that govern everything from the very small subatomic scale to the very large cosmic scale. The study of physics provides us with an unparalleled power of analysis that is useful in the study of the other sciences, engineering and mathematics, as well as in daily life.

The fourth edition of *Physics for the IB Diploma* is a text that has been written with the needs of the IB student in mind. It covers the new syllabus that was examined for the first time in May 2003. The fourth edition covers the entire IB syllabus, including all options at both standard level (SL) and higher level (HL). It includes a chapter on the role of physics in the theory of knowledge (TOK) along with many discussion questions for TOK. The questions and problems at the end of each chapter have been expanded and there are answers at the end of the book for all those involving calculation (and for some others too). Each chapter opens with a list of objectives, which include the important formulae that will be covered in the chapter.

Part I of the book covers the core material and the additional higher level (AHL) material. The title and running heads of each chapter clearly indicate whether the chapter is part of the core or AHL. Part II covers the optional subjects. Two options available only to standard level students (Option A, Mechanics, and Option B, Atomic and Nuclear Physics) are the same as the corresponding AHL material and therefore these two options are not presented separately. Another standard level option, Option C, Energy, includes an entire chapter from AHL Thermal Physics, namely Thermodynamics. Thermodynamics is presented in Chapter 3.4. Option E, The History and Development of Physics, is presented in Part II as a separate set of chapters but much of the material is common to both core and AHL material; those parts of the syllabus are not repeated in Option E. Instead, there are references to the appropriate sections in Part I.

The division of this book into chapters and sections follows the syllabus published by the International Baccalaureate Organization (IBO) as closely as possible. This does not mean, however, that this particular order should be followed. Within reason, the sections are fairly independent of each other and so alternative teaching sequences may be followed. It must also be stressed that this book is not an official guide to the IB syllabus nor is this book connected with the IBO in any way.

The book contains many example questions and answers that are meant to make the student more comfortable with solving problems. Some are more involved than others. There are also questions at the end of each chapter, which the student should attempt to answer to test his or her understanding. Even though the IB does not require calculus for physics, I have used calculus, on occasion, in the text and in the questions for the benefit of those students taking both physics and mathematics at higher level. They can apply what they are learning in mathematics in a concrete and well-defined context. However, calculus is not essential for following the book. It is assumed that a student starting a physics course at this level knows the basics of

trigonometry and is comfortable with simple algebraic manipulations.

In questions and examples I have not resisted the temptation to use 10 m s^{-2} as the numerical value of the acceleration due to gravity. I have followed the conventions of symbols used by the IBO in the *Physics Data Booklet* with one major exception. The *Data Booklet* uses the symbol s for displacement. Almost universally, the symbol s is reserved for distance and so s stands for distance in this book, not displacement. Also, I have chosen to call initial velocities, speeds, etc. by v_0 rather than the IBO's u.

I wish to thank my wife Ellie Tragakes for her great help and support with this book. I also want to thank the editors of this book, Una Yeung and Andrew Coleman, and the proofreader, Geoff Amor, for their invaluable help and their great professionalism. Without them this edition would not have been possible.

K. A. Tsokos

Athens

January 2005

A note to the reader

The main text of each chapter contains a number of different features, which are clearly identified by the use of headings or by other typographical means, as outlined below.

Learning outcomes

These are provided as bullet lists at the beginning of each chapter and indicate what you will have learned or be able to do when you have finished studying the chapter.

Important results, laws, definitions and significant formulae

Particularly important material, such as important results, laws, definitions and significant formulae, appear in a shaded box.

Example questions

These occur in nearly all of the chapters. They are indicated by the heading 'Example question(s)' and all have a full answer. It is a good idea to attempt to solve these problems before reading the answers. There are over 500 such example questions in this book.

Material for higher level students

This material is highlighted in a shaded box that is labelled 'HL only'.

Material that is outside the IB syllabus

Some material is included that is outside the IB syllabus and will not be examined in the IB exams. It is included here for two reasons. The first is that I believe that it clarifies syllabus material and in some cases it does so in essential ways. The second is that it gives the interested student a more rounded view of the subject that is not bounded by the rigid syllabus content. Such material is highlighted in a shaded box that is labelled 'Supplementary material'.

Questions

Each chapter ends with a numbered set of questions and problems to solve. Answers to all those that involve calculation are given at the end of the book. Answers are also provided for some other questions where it is useful for students to be able to check their answers.