



# Physics

Student Textbook  
Grade 9

Author: Graham Bone

Advisers: Tilahun Tesfaye Deressu (PhD)  
Endeshaw Bekele Buli

Evaluators: Yosef Mihiret  
Gebremeskel Gebreegziabher  
Yusuf Mohamed



Federal Democratic Republic of Ethiopia  
Ministry of Education

PEARSON

## Acknowledgments

The development, printing and distribution of this student textbook has been funded through the General Education Quality Improvement Project (GEQIP), which aims to improve the quality of education for Grades 1–12 students in government schools throughout Ethiopia.

The Federal Democratic Republic of Ethiopia received funding for GEQIP through credit/financing from the International Development Associations (IDA), the Fast Track Initiative Catalytic Fund (FTI CF) and other development partners – Finland, Italian Development Cooperation, the Netherlands and UK aid from the Department for International Development (DFID).

The Ministry of Education wishes to thank the many individuals, groups and other bodies involved – directly and indirectly – in publishing the textbook and accompanying teacher guide.

The publisher would like to thank the following for their kind permission to reproduce their photographs:

(Key: b-bottom; c-centre; l-left; r-right; t-top)

Alamy Images: GB 9, A1 Canada Photos 65, Alchemy 61, Art Directors and TRIP 117b, B.A.E. Inc 200, Howard Barlow 234c, bljckwinkel 230br, Steve Bloom Images 74b, Bon Appetit 174tl, Chris Cheadle 181, Richard Cooke 114, Design Pics Inc. / RM Content 234tr, Karin Duthie 231, DWImages 198, Michael Dwyer 155, Elvele Images Ltd 144t, Mary Evans Picture Library 174b, Kevin Foy 108, fStop 141c, GIPhotoStock Z 144bl, Mike Goldwater 88t, Digifoto Green 187, Christian Heinrich / ImageBroker 230tr, Images of Africa Photobank 43t, Bjanka Kadie 185b, Lenscap 100t, Bobbie Lerryn 177, Manor Photography 143r, MARKA 20, 111t, Morelease Travel London 133, NASA Images 35, Douglas Peebles Photography 230bl, Reimar 234b, Ivo Roosplod 185c, sciencephotos 174tr, 218c, SCPhotos 125, Jochen Tack 162l, Tetra Images 230tl, The Art Gallery 45t, David Tipling 208, David Wall 234tl, Westend 61 GmbH 106t, Worldspec / NASA 74t, Tony Wright / Earthscapes 31b; Corbis: Colin Garratt; Milepost 92 1 / 2 106b, Dimitri lundt / TempSport 17, NASA / Roger Ressmeyer 60l, Jim Sugar 62, Tetra Images 46b, Ahmad Yusni / epa 143l; Getty Images: 219, AFP 56b, 58, AFP 56b, 58, Malcolm Fife / Photographer's Choice 179, Gavin Hellier / Robert Harding World 172, Spencer Platt 56t, Science and Society Picture Library 67, Siri Stafford / Photodisc 46t (ball); GNU Free Documentation license: Adrian Pingstone 232; iStockphoto: Yunus Arakon 117t, Dan Barnes 166, Steven Braun 134, Arthur Carlo 70t, Mikael Damier 75, Erik de Graaf 54, Elke Dennis 111b, Oleg Fedorenko 152, Trevor Fisher 173b, Joseph Gareri 55, Jose Luis Gutierrez 107t, Ian Hamilton 38, Adam Hicks 31t, Mark Jensen 107bc, Dan Kite 145b, Knappe 178t, Geoff Kuchera 34t, Kate Leigh 173t, Mario Loiseau 127, Chepe Nicoli 178b, Iain Norman 83, Gregory Olsen 141b, Rhoberazzi 107tc, Lawrence Sawyer 34b, Christy Scott 102t, Mark Sheppard 96, Doug Sims 163, Nicholas Skaanild 135, Richard Stouffer 88b, Stephen Strathdee 100b, Alexandr Tovstenko 102b, Duncan Walker 45b, Don Wilkie 160, Dane Wirtzfeld 53, Vladimi Yudin 107b; NASA: 46t (space); NASA: IPEC 175l, 175r; Rex Features: Burger / Phanie 141t; Science Photo Library Ltd: Dr Jeremy Burgess 64t, Mark Burnett 185tl, Chris Butler 43b, D.Roberts 218t, Bernhard Edmaier 109, European Space Agency 44, Adam Hart-Davis 47, Gary Hincks 19, Edward Kinsman 227, Mehau Kulyk 43c, Andrew Lambert Photography 49, 50, 64b, 225t, 225b, Louise Murray 162r, NASA 60r, NOAA 145t, David Nunuk 167, Sam Ogden 146, Pekka Parviainen 226, Royal Astronomical Society 144br, Erich Schrempp 223, Zephyr 237

Cover images: Front: Corbis: Dimitri lundt / TempSport br; iStockphoto: GB/Alamy tr; Science Photo Library Ltd: Andrew Lambert Photography l

All other images © Pearson Education

Every effort has been made to trace the copyright holders and we apologise in advance for any unintentional omissions.

We would be pleased to insert the appropriate acknowledgement in any subsequent edition of this publication.

© Federal Democratic Republic of Ethiopia, Ministry of Education

First edition, 2002 (E.C.)

ISBN: 978-99944-2-016-2

Developed, Printed and distributed for the Federal Democratic Republic of Ethiopia, Ministry of Education by:

Pearson Education Limited

Edinburgh Gate

Harlow

Essex CM20 2JE

England

In collaboration with

Shama Books

P.O. Box 15

Addis Ababa

Ethiopia

All rights reserved; no part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise without the prior written permission of the copyright owner or a licence permitting restricted copying in Ethiopia by the Federal Democratic Republic of Ethiopia, Federal Negarit Gazeta, *Proclamation No. 410/2004 Copyright and Neighboring Rights Protection Proclamation, 10th year, No. 55, Addis Ababa, 19 July 2004.*

Disclaimer

Every effort has been made to trace the copyright owners of material used in this document. We apologise in advance for any unintentional omissions. We would be pleased to insert the appropriate acknowledgement in any future edition

Printed in Malaysia (CTP-VVP)

# Contents

---

<b>Unit 1 Vectors</b>	<b>1</b>
1.1 Representation of vectors	1
1.2 Addition and subtraction of vectors	3
1.3 Some applications of vectors	10
<b>Unit 2 Motion in a straight line</b>	<b>15</b>
2.1 Uniform motion	16
2.2 Uniformly accelerated motion	19
2.3 Graphical description of uniformly accelerated motion	22
2.4 Equations of uniformly accelerated motion	28
2.5 Relative velocity in one dimension	36
<b>Unit 3 Forces and Newton's laws of motion</b>	<b>42</b>
3.1 Forces in nature	43
3.2 Newton's second law	52
3.3 Frictional forces	64
3.4 Newton's third law	71
3.5 Conservation of linear momentum	74
3.6 Collisions	83
3.7 The first condition of equilibrium	84
<b>Unit 4 Work, energy and power</b>	<b>87</b>
4.1 Mechanical work	88
4.2 Work–energy theorem	96
4.3 Conservation of energy	101
4.4 Mechanical power	110
<b>Unit 5 Simple machines</b>	<b>116</b>
5.1 Purposes of machines	116
5.2 Inclined plane, wedge and screw	124
5.3 Levers	128

<b>Unit 6 Fluid statics</b>	<b>140</b>
6.1 Air pressure	141
6.2 Fluid pressure	151
<b>Unit 7 Temperature and heat</b>	<b>171</b>
7.1 Temperature and heat	172
7.2 Expansion of solids, liquids and gases	179
7.3 Quantity of heat, specific heat capacity and heat capacity	191
7.4 Changes of state	199
<b>Unit 8 Wave motion and sound</b>	<b>207</b>
8.1 Wave propagation	207
8.2 Mechanical waves	214
8.3 Properties of waves	221
8.4 Sound waves	228
<b>Index</b>	<b>241</b>

© MOE, FDR Ethiopia  
Not to be republished