

Heinemann is an imprint of Pearson Education Limited, a company incorporated in England and Wales, having its registered office at Edinburgh Gate, Harlow, Essex CM20 2JE. Registered company number: 872828

www.heinemann.co.uk

Heinemann is a registered trademark of Pearson Education Limited

Text © Pearson Education Limited 2008

First published 2008

12 11 10 09 08
10 9 8 7 6 5 4 3 2 1

British Library Cataloguing in Publication Data

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

ISBN 978 0 435691 98 1

Copyright notice

All rights reserved. No part of this publication may be reproduced in any form or by any means (including photocopying or storing it in any medium by electronic means and whether or not transiently or incidentally to some other use of this publication) without the written permission of the copyright owner, except in accordance with the provisions of the Copyright, Designs and Patents Act 1988 or under the terms of a licence issued by the Copyright Licensing Agency, Saffron House, 6–10 Kirby Street, London EC1N 8TS (www.cla.co.uk). Applications for the copyright owner's written permission should be addressed to the publisher.

Edited by Tony Clappison
Index compiled by Wendy Simpson
Designed by Kamae Design

Project managed and typeset by Wearset Ltd, Boldon, Tyne and Wear
Original illustrations © Pearson Education Limited 2008

Illustrated by Wearset Ltd, Boldon, Tyne and Wear

Picture research by Wearset Ltd, Boldon, Tyne and Wear
Cover photo shows the growth of a fluorapatite (calcium fluoride phosphate) crystal from a hexagonal rod to a sphere, composite scanning electron micrographs, © Science Photo Library.
Printed in Spain by Graficas Estella

Acknowledgements

We would like to thank the following for their invaluable help in the development and trialling of this course: Andrew Gelling, Peter Haigh, Amanda Hawkins, Dave Keble, Maggie Perry, Michael Taylor and Chris Wood.

The authors and publisher would like to thank the following for permission to reproduce photographs:

p3 Laguna Design/Science Photo Library; **p4** Cordelia Molloy/Science Photo Library; **p5 T** Alan L. Detrick/Science Photo Library; **p5 M** Charles D. Winters/Science Photo Library; **p6 T** Science Photo Library; **p6 B** Getty Images; **p8** Clive Freeman, The Royal Institution/Science Photo Library; **p11 TL** Phillippe Psalia/Science Photo Library; **p11 TM** Gustoimages/Science Photo Library; **p11 TR** Kevin In Canada; **p11 M** Garry D. McMichael/Science Photo Library; **p15 T** Dave Gent; **p15 M** Jim Zipp/Science Photo Library; **p16** Martyn F. Chillmaid/Science Photo Library; **p17 T** Science Source/Science Photo Library; **p17 M** Rob Ritchie; **p17 B** Rob Ritchie, Collectstamps; **p18** Martyn F. Chillmaid/Science Photo Library; **p19 T** Cordelia Molloy/Science Photo Library; **p19 M** Rob Ritchie; **p19 BM** Rosal/Science Photo Library; **p19 B** Tek Image/Science Photo Library; **p21 M** David Gubernick/AgstockUSA/Science Photo Library; **p21 B** Jiri Loun/Science Photo Library; **p23 M** Dave Gent; **p23 BL** Adey Bryant; **p23 BR** GoGo Images Corporation/Alamy; **p24** Dave Gent; **p25** Dave Gent; **p26** Dave Gent; **p27 T** Dave Gent; **p27 B** Andrew Lambert Photography/Science Photo Library; **p28 TL** David Munns/Science Photo Library; **p28 TR** Image Source/Getty Images; **p28 TM** Maximilian Stock Ltd/Science Photo Library; **p28 B** Charles D. Winters/Science Photo Library; **p31 T** George & Judy Manna/Science Photo Library; **p31 B** John Heseltine/Science Photo Library; **p32 T** Maximilian Stock Ltd/Science Photo Library; **p32 M** Sinclair Stammers/Science Photo Library; **p32 B** Erika Craddock/Science Photo Library; **p33** Bildagentur-Online/TH Foto/Science Photo Library; **p34** Martin

Bond/Science Photo Library; **p35 T** Bsp Vem/Science Photo Library; **p35 B** Mr. Nut/Alamy; **p36 T** Gustoimages/Science Photo Library; **p36 M** Daniel Sambras/Science Photo Library; **p38** Andrew Lambert Photography/Science Photo Library; **p39 BL** Edward Rozzo/Corbis; **p39 BM** Burn; **p47** Alex Bartel/Science Photo Library; **p48** Steve Gschmeier/Science Photo Library; **p51** Dorling Kindersley; **p53** Sleeper/Service on Flickr; **p54** Dave Gent; **p55** Huhtamaki; **p56** Peter Menzel/Science Photo Library; **p57 T** Getty Images; **p57 B** Cordelia Molloy/Science Photo Library; **p61 T** Peter Menzel/Science Photo Library; **p61 B** Sainsburys; **p62** Estate of Francis Bello/Science Photo Library; **p66** Cordelia Molloy/Science Photo Library; **p67** Martyn F. Chillmaid/Science Photo Library; **p75** Mason Morfit, Peter Arnold Inc./Science Photo Library; **p76** Maximilian Stock Ltd/Science Photo Library; **p79** Mehau Kuyk/Science Photo Library; **p82** Dr Jurgen Scriba/Science Photo Library; **p83** NASA/Science Photo Library; **p85** Will Davey; **p94** Colin Cuthbert/Science Photo Library; **p98** Blend Images/Alamy; **p99 T** Erich Schrempp/Science Photo Library; **p99 B** Zephyr/Science Photo Library; **p111** David Munns/Science Photo Library; **p114 M** Rob Ritchie; **p114 B** Rob Ritchie; **p119** Gianni Tortoli/Science Photo Library; **p121** Martyn F. Chillmaid/Science Photo Library; **p131** Charles D. Winters/Science Photo Library; **p134** Science Photo Library; **p135 T** Science Photo Library; **p135 M** Science Photo Library; **p137 T** Martyn F. Chillmaid/Science Photo Library; **p137 B** Rob Ritchie; **p139** Charles D. Winters/Science Photo Library; **p140** Science Photo Library; **p142 BL** Science Photo Library; **p142 BR** Thomas Deerinck, NCMIR/Science Photo Library; **p143** David Munns/Science Photo Library; **p144** Charles D. Winters/Science Photo Library; **p146** Edward Kinsman/Science Photo Library; **p147 T** The Great Shadow; **p147 M** Dave Gent; **p148** CCI Archives/Science Photo Library; **p151** Mary Evans Picture Library/Alamy; **p153** JUPITERIMAGES/Comstock Images/Alamy; **p156** Rob Ritchie; **p165** Dr Mark J. Winter/Science Photo Library; **p174** Rob Ritchie; **p179 T** Rob Ritchie; **p179 B** Martyn F. Chillmaid/Science Photo Library; **p180** Science, Industry & Business Library/New York Public Library/Science Photo Library; **p184** Rob Ritchie; **p188** E.R. Degginger/Science Photo Library; **p190** Rob Ritchie; **p191** Nikon/Scott Andrews/NASA/Science Photo Library; **p192 M** Martin Bond/Science Photo Library; **p192 B** Vanessa Vick/Science Photo Library; **p193** Justin Sullivan/Getty Images; **p201** Mauro Fermariello/Science Photo Library; **p204 TL** Tysto Nicogag; **p204 ML** Steve Fairman; **p204 MR** James King-Holmes/Science Photo Library; **p204 B** Dave Gent; **p206 T** Astrid & Hanns-Frieder Michler/Science Photo Library; **p206 M** Dick Luria/Science Photo Library; **p207 T** Charles D. Winters/Science Photo Library; **p207 M** Dave Gent; **p207 B** Dave Gent; **p210** Science Photo Library; **p214** Dave Gent; **p215 T** Dave Gent; **p215 M** Dave Gent; **p216 T** Andrew Syred/Science Photo Library; **p216 M** John Bavosi/Science Photo Library; **p218** Dave Gent; **p219** Dave Gent; **p221** Dave Gent; **p222** Dave Gent; **p223** Justin Kase Ztwoz/Alamy

Every effort has been made to contact copyright holders of material reproduced in this book. Any omissions will be rectified in subsequent printings if notice is given to the publisher.

Websites

There are links to websites relevant to this book. In order to ensure that the links are up-to-date, that the links work, and that links are not inadvertently made to sites that could be considered offensive, we have made the links available on the Heinemann website at www.heinemann.co.uk/hotlinks. When you access the site, the express code is 1981P.

Exam Café student CD-ROM

© Pearson Education Limited 2008

The material in this publication is copyright. It may be edited and printed for one-time use as instructional material in a classroom by a teacher, but may not be copied in unlimited quantities, kept on behalf of others, passed on or sold to third parties, or stored for future use in a retrieval system. If you wish to use the material in any way other than that specified you must apply in writing to the publisher.

Original illustrations, screen designs and animation by Michael Heald
Photographs © iStock Ltd
Developed by Elektra Media Ltd

Technical problems

If you encounter technical problems whilst running this software, please contact the Customer Support team on 01865 888108 or email software.enquiries@heinemann.co.uk