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COURSE PLANNER — AUSTRALIAN CURRICULUM: SCIENCE YEARS 7–10

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Science Understanding

	Biological sciences			Chemical sciences		Earth and space sciences		Physical sciences	
Year 7		There are differences within and between groups of organisms; classification helps organise this diversity (ACSSU111)	Interactions between organisms can be described in terms of food chains and food webs; human activity can affect these interactions (ACSSU112)		Mixtures, including solutions, contain a combination of pure substances that can be separated using a range of techniques (ACSSU113)	Predictable phenomena, including seasons and eclipses, are caused by the relative positions of the sun, Earth and the moon (ACSSU115)	Some of Earth's resources are renewable, but others are non-renewable (ACSSU116) Water is an important resource that cycles through the environment (ACSSU222)		Change to an object's motion is caused by unbalanced forces acting on the object (ACSSU117) Earth's gravity pulls objects towards the centre of the Earth (ACSSU118)
Year 8	Cells are the basic units of living things and have specialised structures and functions (ACSSU149) Multi-cellular organisms contain systems of organs that carry out specialised functions that enable them to survive and reproduce (ACSSU150)			The properties of the different states of matter can be explained in terms of the motion and arrangement of particles (ACSSU151) Differences between elements, compounds and mixtures can be described at a particle level (ACSSU152)	Chemical change involves substances reacting to form new substances (ACSSU225)		Sedimentary, igneous and metamorphic rocks contain minerals and are formed by processes that occur within Earth over a variety of timescales (ACSSU153)	Energy appears in different forms including movement (kinetic energy), heat and potential energy, and causes change within systems (ACSSU155)	
Year 9	Multi-cellular organisms rely on coordinated and interdependent internal systems to respond to changes to their environment (ACSSU175)		Ecosystems consist of communities of interdependent organisms and abiotic components of the environment; matter and energy flow through these systems (ACSSU176)	All matter is made of atoms which are composed of protons, neutrons and electrons; natural radioactivity arises from the decay of nuclei in atoms (ACSSU177)	Chemical reactions involve rearranging atoms to form new substances; during a chemical reaction, mass is not created or destroyed (ACSSU178) Chemical reactions, including combustion and the reactions of acids, are important in both non-living and living systems and involve energy transfer (ACSSU179)		The theory of plate tectonics explains global patterns of geological activity and continental movement (ACSSU180)	Energy transfer through different mediums can be explained using wave and particle models (ACSSU182)	
Year 10		The transmission of heritable characteristics from one generation to the next involves DNA and genes (ACSSU184) The theory of evolution by natural selection explains the diversity of living things and is supported by a range of scientific evidence ACSSU185)		The atomic structure and properties of elements are used to organise them in the Periodic Table (ACSSU186)	Different types of chemical reactions are used to produce a range of products and can occur at different rates (ACSSU187)	The universe contains features including galaxies, stars and solar systems and the Big Bang theory can be used to explain the origin of the universe (ACSSU188)	Global systems, including the carbon cycle, rely on interactions involving the biosphere, lithosphere, hydrosphere and atmosphere (ACSSU189)	Energy conservation in a system can be explained by describing energy transfers and transformations (ACSSU190)	The motion of objects can be described and predicted using the laws of physics (ACSSU229)
Key concepts (Big Ideas)	**The form and features of living things are related to the functions that their body systems perform** (Structure and function)	**A diverse range of living things have evolved on Earth** (Diversity and evolution)	**Living things are interdependent and interact with each other and their environment** (Interdependence)	**The chemical and physical properties of substances are determined by their structure** (Properties and structure)	**Substances change and new substances are produced by rearranging atoms through atomic interactions and energy transfer** (Interaction and change)	**Earth is part of a solar system that is part of a larger universe** (Systems in space)	**Earth is subject to change within and on its surface over a range of timescales as a result of natural processes and human use of resources** (Dynamic Earth)	**Energy can be transferred and transformed from one form to another** (Energy and its transformations)	**A range of forces affect the behaviour of objects** (Forces and motion)

	Science as a Human Endeavour	Science Inquiry Skills
Years 7–8	**Nature and development of science** Scientific knowledge changes as new evidence becomes available, and some scientific discoveries have significantly changed people's understanding of the world (ACSHE119/134) Science knowledge can develop through collaboration and connecting ideas across the disciplines of science (ACSHE223/226) **Use and influence of science** Science and technology contribute to finding solutions to a range of contemporary issues; these solutions may impact on other areas of society and involve ethical considerations (ACSHE120/135) Science understanding influences the development of practices in areas of human activity such as industry, agriculture and marine and terrestrial resource management (ACSHE121/136) People use understanding and skills from across the disciplines of science in their occupations (ACSHE224/227)	**Questioning and predicting** Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge (ACSIS124/139) **Planning and conducting** Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed (ACSIS125/140) In fair tests, measure and control variables, and select equipment to collect data with accuracy appropriate to the task (ACSIS126/141) **Processing and analysing data and information** Construct and use a range of representations, including graphs, keys and models to represent and analyse patterns or relationships, including using digital technologies as appropriate (ACSIS129/144) Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions (ACSIS130/145) **Evaluating** Reflect on the method used to investigate a question or solve a problem, including evaluating the quality of the data collected, and identify improvements to the method (ACSIS131/146) Use scientific knowledge and findings from investigations to evaluate claims (ACSIS132/234) **Communicating** Communicate ideas, findings and solutions to problems using scientific language and representations using digital technologies as appropriate (ACSIS133/148)
Years 9–10	**Nature and development of science** Scientific understanding, including models and theories, are contestable and are refined over time through a process of review by the scientific community (ACSHE157/191) Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries (ACSHE158/192) **Use and influence of science** People can use scientific knowledge to evaluate whether they should accept claims, explanations or predictions (ACSHE160/194) Advances in science and emerging sciences and technologies can significantly affect people's lives, including generating new career opportunities (ACSHE161/195) The values and needs of contemporary society can influence the focus of scientific research (ACSHE228/230)	**Questioning and predicting** Formulate questions or hypotheses that can be investigated scientifically (ACSIS164/198) **Planning and conducting** Plan, select and use appropriate investigation methods, including field work and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods (ACSIS165/199) Select and use appropriate equipment, including digital technologies, to systematically and accurately collect and record data (ACSIS166/200) **Processing and analysing data and information** Analyse patterns and trends in data, including describing relationships between variables and identifying inconsistencies (ACSIS169/203) Use knowledge of scientific concepts to draw conclusions that are consistent with evidence (ACSIS170/204) **Evaluating** Evaluate conclusions, including identifying sources of uncertainty and possible alternative explanations, and describe specific ways to improve the quality of the data (ACSIS171/205) Critically analyse the validity of information in secondary sources and evaluate the approaches used to solve problems (ACSIS172/206) **Communicating** Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations (ACSIS174/208)

Suggested teaching program

Chapter 4: Resources

Time allocation: 4 weeks

Context and overview
In year 7, students explore the notion of renewable and non-renewable resources and consider how this classification depends on the timescale considered. Students formulate hypotheses and analyse data to draw and analyse conclusions using primary and secondary sourced evidence.
Syllabus outcomes addressed
• Some of Earth's resources are renewable but others are non-renewable ACSSU116 • People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity ACSHE121 • Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge ACSIS124 • Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed ACSIS125 • Measure and control variables, select equipment appropriate to the task and collect data with accuracy ACSIS126 • Construct and use a range of representations, including graphs, keys and models to represent and analyse patterns or relationships in data using digital technologies as appropriate ACSIS129 • Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence ACSIS130 • Use scientific knowledge and findings from investigations to evaluate claims based on evidence ACSIS132 • Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate ACSIS133
Achievement standards
Students analyse how the uses of resources depends on the way they are formed and cycle through Earth's systems. Students describe social and technological factors that have influenced scientific developments and predict how future applications of science and technology may affect people's lives. Students design questions that can be investigated using a range of inquiry skills. They design methods that include the control and accurate measurement of variables and systematic collection of data and describe how they considered ethics and safety. They analyse trends in data, identify relationships between variables and reveal inconsistencies in results. They analyse their methods and the quality of their data, and explain specific actions to improve the quality of their evidence. They evaluate others' methods and explanations from a scientific perspective and use appropriate language and representations when communicating their findings and ideas to specific audiences.

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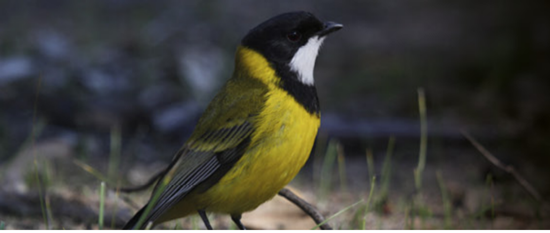

Student book section	WA Syllabus links	Suggested indicators of learning and understanding	Suggested teaching and learning activities	Resources
4.1 Resources on Earth are either renewable or non-renewable **(pages 62–63)**	*Science Understanding* ACSSU116 *Science as a Human Endeavour* ACSHE121 *Science Inquiry Skills* ACSIS133	By the end of this unit, students should be able to: • define resource • explain the difference between renewable and non-renewable resources • provide examples of renewable and non–renewable resources.	**Resource ID walk** Using the activity provided on the Project Learning Tree website, students can take a short walk around the streets around the school and identify as many resources or evidence of resources as they can and classify them as either renewable or non-renewable.	**Oxford Science 7 WA resources** • Check your learning, page 63 **Additional resources** Project Learning Tree activity about whether a resource is renewable or not. https://www.plt.org/family-activities-renewable-or-not
4.2 Renewable resources can be replaced quickly **(pages 64–65)**	*Science Understanding* ACSSU116 *Science as a Human Endeavour* ACSHE121 *Science Inquiry Skills* ACSIS124 ACSIS125 ACSIS126 ACSIS129 ACSIS130 ACSIS133	By the end of this unit, students should be able to: • define turbine, generator and greenhouse emissions • describe the ways in which electricity is generated in Australia in terms of renewable and non-renewable resources • explain the characteristics of a renewable resource.	**Challenge 4.2** *Can you increase the output of a power station?* Students investigate the workings of a model power station and modify the design to improve efficiency.	**Oxford Science 7 WA resources** • Check your learning, page 65 • Challenge 4.2, page 186

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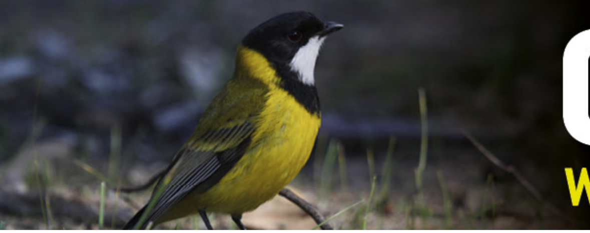

4.3 Renewable resources can be harnessed to provide energy **(pages 66–67)**	*Science Understanding* ACSSU116 *Science as a Human Endeavour* ACSHE120 ACSHE121 *Science Inquiry Skills* ACSIS124 ACSIS125 ACSIS126 ACSIS129 ACSIS130 ACSIS132 ACSIS133	By the end of this unit, students should be able to: • define solar, hydroelectrical and geothermal • provide examples of renewable resources that can be used to generate electricity • explain the similarities between all forms of renewable electricity generation.	**Challenge 4.3** *Can you increase the power of solar cells?* Students investigate the design of solar cells to improve their efficiency. **Renewable and non-renewable energy sources** Students can complete the interactive tutorial about different sources of energy.	**Oxford Science 7 WA resources** • Check your learning, page 67 • Challenge 4.3, page 188 **Additional resources** Energy and the Environment interactive tutorial about renewable and non-renewable energy sources. http://www.childrensuniversity.manchester.ac.uk/interactives/science/energy/renewable/

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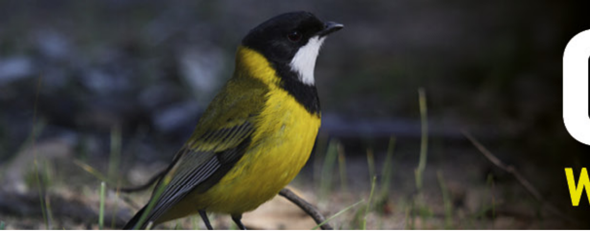
4.4 Non-renewable resources are limited **(pages 68–69)**	*Science Understanding* ACSSU116 *Science as a Human Endeavour* ACSHE119 ACSHE121 *Science Inquiry Skills* ACSIS124 ACSIS125 ACSIS126 ACSIS130 ACSIS132 ACSIS133	By the end of this unit, students should be able to: • define fossil fuel, mineral and ores. • describe how electricity can be generated from uranium • provide examples of non–renewable sources of energy • explain the key characteristic of a non–renewable resource.	**Experiment 4.4A** *What if a muffin were mined in different ways?* Students compare the effectiveness of different mining methods and their impact on the environment. **Experiment 4.4B** *What if a metal were obtained from a mineral?* Students investigate electrolysis as a method of extracting copper from copper sulphate. **Comparing energy resources** Students can investigate the advantages and disadvantages of various energy sources using the information provided on the Energy Resources website and determine which source of energy is the best. Students will need to develop a list of criteria in order to evaluate the 'best' resource.	**Oxford Science 7 WA resources** • Check your learning, page 69 • Experiment 4.4A, page 189 • Experiment 4.4B, page 190 **Additional resources** This Energy Resources website contains information, video clips, advantages, disadvantages, summaries and quizzes on all major energy types. http://www.darvill.clara.net/altenerg/index.htm



4.5 Soil is one of our most valuable resources **(pages 70–71)**	*Science Understanding* ACSSU116 *Science as a Human Endeavour* ACSHE121 *Science Inquiry Skills* ACSIS125 ACSIS126 ACSIS129 ACSIS130 ACSIS133	By the end of this unit, students should be able to: • define humus and land degradation • provide examples of soil as a resource • explain why soil is such an important resource • identify soil as a renewable or non-renewable resource.	**Experiment 4.5** *What if different soils were exposed to water?* Students investigate the components of soils and how different soil components affects water absorption. **Interactive soil** Students can complete a number of online interactives from the Forces of Change website to learn more about the importance of soil as a resource.	**Oxford Science 7 WA resources** • Check your learning, page 71 • Experiment 4.5, page 191 **Additional resources** The Forces of Change website provides a video tour of the 'Dig it! The Secrets of Soil' Smithsonian's National Museum of Natural History exhibition as well as a range of other activities. http://forces.si.edu/soils/

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4.6 our future depends on careful management of resources **(pages 72–73)**	*Science Understanding* ACSSU116 *Science as a Human Endeavour* ACSHE223 ACSHE120 ACSHE121 *Science Inquiry Skills* ACSIS124 ACSIS125 ACSIS130 ACSIS132 ACSIS133	By the end of this unit, students should be able to: • define low-emission, hybrid vehicle, ethanol and efficiency • explain why it is important to use resources sustainably • provide examples of methods of conserving resources.	**Challenge 4.6** *Resources for your future* Students prepare and present a report about the use and depletion of one natural resource. **Investigating biofuels as an alternative** Students can use the Biofuels of Australia as a starting point for investigating biofuels as an alternative to burning fossil fuels in cars. Students may like to investigate electric and hybrid cars as well or instead.	**Oxford Science 7 WA resources** • Check your learning, page 73 • Challenge 4.6, page 192
				Additional resources Biofuels of Australia website contains lost of information about the development and use of biofuels in Australia. It also contains a list of mythbusters. http://biofuelsassociation.com.au/

4.7 Green jobs will increase in the future **(pages 74–75)**	*Science Understanding* ACSSU116 *Science as a Human Endeavour* ACSHE223 ACSHE120 ACSHE121 *Science Inquiry Skills* ACSIS133	By the end of this unit, students should be able to: • describe what a 'green job' is • provide examples of 'green jobs' • explain the importance of green jobs to the future of the planet • relate developing scientific knowledge with the creation of new green jobs.	**Investigating green jobs** Students can use the Green Career site to find 'green jobs' in their area and to find out more about what they might entail.	**Oxford Science 7 WA resources** • Extend your learning, page 75 **Additional resources** Green Career is a job search site for sustainable, environmental and 'green' jobs in Australia and New Zealand. http://www.greencareer.net.au/
4 Review **(pages 76–78)**	*Science Understanding* ACSSU116 *Science Inquiry Skills* ACSIS133	By the end of this unit, students should be able to: • define all Key Words listed on page 78 • explain the difference between renewable and non-renewable resources in terms of timescales and the ways in which they are formed and cycled through the environment • identify areas of personal strengths and weaknesses in their knowledge and understanding of the topic.	**Revision activities** • Students could play celebrity heads with the Key Words list. • Students can make dominoes with Key Words on one end and definitions/diagrams/examples on the other end. • Students can create mind maps, Venn diagrams or other graphic organisers to summarise the key concepts of this chapter. • Peer teaching: students can work in groups to reteach the content of the unit to the class for the purpose of revision. Each group could be allocated a double-page to summarise.	**Oxford Science 7 WA resources** • Review questions, pages 76–77 • Research topics, page 77 • Key Words list, page 78

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OXFORD SCIENCE 8
WESTERN AUSTRALIAN CURRICULUM

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Suggested teaching program

Chapter 4: Chemical elements

Time allocation: 4 weeks

Context and overview

In year 8, students explore changes in matter at a particle level, and distinguish between chemical and physical change. Students use experimentation to isolate relationships between components in systems and explain these relationships through increasingly complex representations. They make predictions and propose explanations, drawing on evidence to support their views

Syllabus outcomes addressed

- Properties of the different states of matter can be explained in terms of the motion and arrangement of particles ACSSU151
- Differences between elements, compounds and mixtures can be described at a particle level ACSSU152
- Scientific knowledge has changed peoples' understanding of the world and is refined as new evidence becomes available ACSHE134
- Science knowledge can develop through collaboration across the disciplines of science and the contributions of people from a range of cultures ACSHE226
- People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity ACSHE136
- Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge ACSIS139
- Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed ACSIS140
- Measure and control variables, select equipment appropriate to the task and collect data with accuracy ACSIS141
- Construct and use a range of representations, including graphs, keys and models to represent and analyse patterns or relationships in data using digital technologies as appropriate ACSIS144
- Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence ACSIS145
- Reflect on scientific investigations including evaluating the quality of the data collected, and identifying improvements ACSIS146
- Use scientific knowledge and findings from investigations to evaluate claims based on evidence ACSIS234
- Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate ACSIS148

Achievement standards

Students compare physical and chemical changes and use the particle model to explain and predict the properties and behaviours of substances. Students examine the different science knowledge used in occupations. They explain how evidence has led to an improved understanding of a scientific idea and describe situations in which scientists collaborated to generate solutions to contemporary problems.

Students identify and construct questions and problems that they can investigate scientifically. They consider safety and ethics when planning investigations, including designing field or experimental methods. They identify variables to be changed, measured and controlled. Students construct representations of their data to reveal and analyse patterns and trends, and use these when justifying their conclusions. They explain how modifications to methods could improve the quality of their data and apply their own scientific knowledge and investigation findings to evaluate claims made by others. They use appropriate language and representations to communicate science ideas, methods and findings in a range of text types.

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Student book section	WA Syllabus links	Suggested indicators of learning and understanding	Suggested teaching and learning activities	Resources
4.1 The properties of matter can be described **(pages 62–63)**	*Science Understanding* ACSSU151 ACSSU152 *Science Inquiry Skills* ACSIS139 ACSIS140 ACSIS141 ACSIS144 ACSIS145 ACSIS148	By the end of this unit, students should be able to: • define matter, mass, volume, physical properties and chemical properties • describe the three states of matter • provide examples of substances in the three states of matter • explain the importance of understanding the properties of a substance.	**What if?** Students investigate the rate of diffusion of M&M dye in water. **Experiment 4.1** *Comparing states of matter* Students investigate the key characteristics that distinguish between solids, liquids and gases. **Physical vs. chemical properties** Students can extend their understanding of physical and chemical properties by watching the Study.com video tutorial and completing the quiz.	**Oxford Science 8 Western Australian Curriculum resources** • What if? Page 61 • Check your learning, page 63 • Experiment 4.1, page 178 **Additional resources** Study.com website has a video tutorial and quiz about chemical and physical properties of matter: http://study.com/academy/lesson/matter-physical-and-chemical-properties.html#lesson
4.2 Scientists' understanding of matter has developed over thousands of years **(pages 64–65)**	*Science Understanding* ACSSU151 ACSSU152 *Science as a Human Endeavour* ACSHE134 ACSHE226	By the end of this unit, students should be able to: • define theory, atom and chemistry • describe how our understating of matter has changed over time • explain how scientific experimentation and technological developments are involved in refining theories • relate the properties of the states of matter to the particles.	**Atomic theory timeline** Students can develop a timeline of the development of the atomic theory. They may use information from the Soft Schools website and present the timeline around the room using an appropriate scale. Encourage students to indicate significant technological developments in the timeline.	**Oxford Science 8 Western Australian Curriculum resources** • Extend your understanding, page 65 **Additional resources** Soft Schools interactive timeline of the development of the atomic theory: http://www.softschools.com/timelines/atomic_theory_timeline/95/

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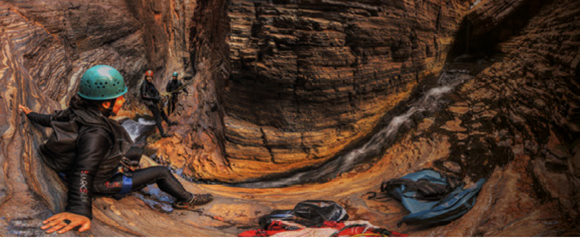

4.3 The particle model explains matter **(pages 66–67)**	*Science Understanding* ACSSU151 ACSSU152 *Science as a Human Endeavour* ACSHE136 *Science Inquiry Skills* ACSIS139 ACSIS140 ACSIS141 ACSIS144 ACSIS145 ACSIS146 ACSIS234 ACSIS148	By the end of this unit, students should be able to: • define the particle theory of matter and diffusion • explain how kinetic and thermal energy affect the rate of diffusion • relate kinetic energy to the particle theory of matter.	**Challenge 4.3A** *Modelling matter* Students create models of the states of matter demonstrating their understanding of the particle theory of matter. **Challenge 4.3B** *Making a cuppa* Students observe diffusion of tea and investigate the effect of temperature on the rate of diffusion. **Investigating how particles differ between solids, liquids and gases** Students can work through the Bitesize overview of the particle model.	**Oxford Science 8 Western Australian Curriculum resources** • Check your learning, page 67 • Challenge 4.3A, page 179 • Challenge 4.3B, page 179 **Additional resources** BBC Bitesize on the particle model: http://www.bbc.co.uk/bitesize/ks3/science/chemical_material_behaviour/particle_model/activity/
4.4 The particle model can explain the properties of matter **(pages 68–69)**	*Science Understanding* ACSSU151 ACSSU152 *Science as a Human Endeavour* ACSHE136 *Science Inquiry Skills* ACSIS139 ACSIS140 ACSIS144 ACSIS145 ACSIS148	By the end of this unit, students should be able to: • define tensile strength, hardness, viscosity, compressibility, incompressible and density • describe how to calculate the density of a liquid, a regularly shaped and irregularly shaped solid • provide examples of substances of high and low tensile strength, high and low hardness, high and low viscosity and high and low density • explain strength, hardness, viscosity, compressibility and density in terms of the particles involved.	**Experiment 4.4** *The density den* Students calculate the density of water, regular and irregular shaped objects based on experimental data. **Investigating density** Students can investigate density in the PHeT simulation. Encourage students to explain the changes in volume and mass in terms of their effect on density and why that might affect an object's buoyancy.	**Oxford Science 8 Western Australian Curriculum resources** • Check your learning, page 69 • Experiment 4.4, page 180 **Additional resources** PHeT simulation: http://phet.colorado.edu/sims/density-and-buoyancy/density_en.html

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4.5 Increasing kinetic energy in matter causes it to expand **(pages 70–71)**	*Science Understanding* ACSSU151 ACSSU152 *Science as a Human Endeavour* ACSHE136 *Science Inquiry Skills* ACSIS139 ACSIS140 ACSIS141 ACSIS144 ACSIS145 ACSIS234 ACSIS148	By the end of this unit, students should be able to: • define melting point and boiling point • describe the differences between expansion and contraction of a substance • explain why heat causes expansion of substances • relate the motion of particles to their thermal and kinetic energy.	**Experiment 4.5A** *Effect of heat* Students investigate the effect of heat on solids, liquids and gases. **Experiment 4.5B** *From ice to steam* Students determine the melting and boiling points of water experimentally. **Extra activities** Students can complete some of the other activities listed on the Inquiry In Action website to extend their understanding of how heat affects matter.	**Oxford Science 8 Western Australian Curriculum resources** • Check your learning, page 71 • Experiment 4.5A, page 182 • Experiment 4.5B, page 184 **Additional resources** Inquiry in Action website has a number of activities involving how temperature affects matter: http://www.inquiryinaction.org/classroomactivities/topic.php?topic=Temperature%20Affects%20Matter

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4.6 Atoms and elements make up matter **(pages 72–73)**	*Science Understanding* ACSSU151 ACSSU152 *Science as a Human Endeavour* ACSHE134 *Science Inquiry Skills* ACSIS139 ACSIS140 ACSIS141 ACSIS144 ACSIS145 ACSIS148	By the end of this unit, students should be able to: • define element, monatomic, diatomic and periodic table • describe the key features of the periodic table, including periods and groups • list the first 20 elements of the periodic table • relate the atomic number and mass number of an element to the number of subatomic particles.	**Challenge 4.6A** *Classifying elements* Students investigate the nomenclature of the periodic table and some of the methods of classifying the elements. **Challenge 4.6B** *Identifying the elements* Students investigate an element, its position in the periodic table and its main physical and chemical properties. **Experiment 4.6** *Properties of the elements* Students investigate some of the physical and chemical properties of metals. **Build your own atoms** Students can experiment with sub-atomic particles and build their own atoms, examining charge, atomic number, mass number and atomic stability using the PHET atom builder.	**Oxford Science 8 Western Australian Curriculum resources** • Check your learning, page 73 • Challenge 4.6A, page 185 • Challenge 4.6B, page 186 • Experiment 4.6, page 187 **Additional resources** PHET atom builder website: https://phet.colorado.edu/sims/html/build-an-atom/latest/build-an-atom_en.html

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4.7 Atoms bond together to make molecules and compounds **(pages 74–75)**	*Science Understanding* ACSSU151 ACSSU152 *Science as a Human Endeavour* ACSHE134 *Science Inquiry Skills* ACSIS139 ACSIS140 ACSIS141 ACSIS144 ACSIS145 ACSIS148	By the end of this unit, students should be able to: • define molecule, compound, bonded, molecular element, molecular compounds and polymers • provide examples of elements, molecules, compounds, mixtures • explain the difference between an element, molecule, compound and mixture.	**Experiment 4.7** *Decomposing copper carbonate* Students investigate a compound and determine that a compound is made up of elements. **Revising compounds and mixtures** Students can complete the Bitesize tutorial including the activity and quiz to test their understanding of compounds and mixtures.	**Oxford Science 8 Western Australian Curriculum resources** • Check your learning, page 75 • Experiment 4.7, page 188 **Additional resources** BBC Bitesize compounds and mixture revision: http://www.bbc.co.uk/bitesize/ks3/science/chemical_material_behaviour/compounds_mixtures/revision/1/
4 Review **(pages 76–78)**	*Science Understanding* ACSSU151 ACSSU152 *Science as a Human Endeavour* ACSHE134 *Science Inquiry Skills* ACSIS148	By the end of this unit, students should be able to: • define all Key Words listed on page 78 • explain the properties of the states of matter in terms of the motion and arrangement of particles • explain the difference between elements, compounds and mixtures at a particle level • identify areas of personal strengths and weaknesses in their knowledge and understanding of the topic.	**Revision activities** • Students could play celebrity heads with the Key Words list • Students can make dominoes with Key Words on one end and definitions/diagrams/examples on the other end • Students can create mind maps, Venn diagrams or other graphic organisers to summarise the key concepts of this chapter • Peer teaching: students can work in groups to reteach the content of the unit to the class for the purpose of revision. Each group could be allocated a double-page to summarise	**Oxford Science 8 Western Australian Curriculum resources** • Review questions, pages 76–77 • Research topics, page 77 • Key Words list, page 78

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Chemical elements

4.1 The properties of matter can be described

Teacher notes (pages 62–63)

Introducing the chapter

Students should have prior knowledge of a large amount of this topic from Science in Year 7, including the particle model of matter, the physical properties of matter and the separation of mixtures. This chapter will build on previous knowledge and skills, extending the topic to a greater depth. Matter is the name given to all substances. To be called matter the substance must have mass and volume.

Teaching tips: Student understanding

Questioning of students or a pre-test would be useful in revealing students' understanding and any misconceptions. The hands-on activities provided in this chapter are recommended in order to engage students with this topic.

Teaching tips: Ability levels

The concepts presented in this chapter can be overwhelming for those students with lower abilities, yet they can often cope quite well with the hands-on activities. Most students think they have to memorise the periodic table, but this idea is out of date. The periodic table is usually provided in senior chemistry exams and so students should have access to the periodic table in the assessment tasks at this level. Teaching students how to use the table and where to look for various elements is essential.

Differentiation

For less able students:

Less able students could draw up a four-column table with the headings solids, liquids, gases and plasma. Students brainstorm as many of each type as they can think of for each heading. Keep in mind that students will encounter much more difficulty with plasma in this task.

For more able students:

More able students may wish to use an 'entry ticket' task where they brainstorm as much as they can about what they already know about the states of matter. Some may already have a good understanding of the particle model and may be able to illustrate each of the states of matter.

Additional activity: Identifying states of matter

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Students draw a scene in which many examples of the states of matter can be identified. An example could be the school yard, with a drinking fountain (liquid), a flag moving in the wind (gas) and a student kicking a ball (solid). Students complete their comprehensive illustrations on an A3 sheet of paper and then swap with another student to see if they can identify all the examples of solids, liquids and gases. You can discuss any examples that students are unsure about (e.g. a melting ice cream).

Additional activity: Solids, liquids and gases

Water is an excellent example to differentiate between solids, liquids and gases, as students know the different states of water:

- solid: ice/iceberg
- liquid: water/ocean
- gas: steam/clouds

Ask students to identify more examples of the states of matter (not necessarily based on water).

Additional activity: Minute paper

At the end of this section/topic, give students a small piece of paper (an eighth of an A4 page at the most) and ask them to summarise what they have learnt on this paper in one minute. This minute paper can allow you to gauge how well students understood the new concepts introduced and focus on aspects that they may benefit from revisiting at the start of the next lesson. Minute papers can have the students' names on the back or handed in anonymously.

Going further

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

Chem4Kids: Plasma basics
The webpage contains a video explaining the nature and applications of plasma.

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4.2 Scientists' understanding of matter has developed over thousands of years

Teacher notes (pages 64–65)

Introducing the topic

This section explores the history of science and some of the most important scientists who study chemistry. Science involves developing hypotheses, testing them with reproducible experiments and modifying ideas. When an idea is supported by all the current evidence, it then becomes a theory. The particle theory of matter is a great example of this – it has been tested and refined by scientists over more than 2000 years.

Teaching tips: Electrons through the ages

Electrons are a good example of something that we have learnt more and more about. The Ancient Greeks thought they might exist, and then a series of breakthroughs in the twentieth century saw them shift from theory to fact. Students could also use this as a research task.

Teaching tips: Modern science

The invention of new technologies means that more and more is being discovered about science all the time. One example of this is the microscope. Ask students what the invention of the microscope meant for science. Then ask them to think about other technology that has led to new insights and breakthroughs in science. There are many!

Additional activity: Archimedes in his bath

The story of Archimedes' bath is famous. While taking a bath, Archimedes noticed that the water level rose when he got in. This is how many people think he made his discovery about density. Students often learn better by seeing things done rather than just learning about them. Fill a garbage bin with water and ask students to submerge large objects in it. They can then use the amount of displaced water and the weight of the object (mass) to calculate the density. Ideally, students should test differently shaped objects of the same mass.

Additional activity: Developing the atom

John Dalton's work was essential to our understanding of the atom, but he certainly wasn't alone. Ernest Rutherford, JJ Thomson, James Chadwick, Niels Bohr and Erwin Schrodinger all developed Dalton's model to create the view of the atom that we have today. Students could research one of the scientists above, and produce a poster about his life and contributions to the atomic model.

Going further

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A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

BBC Bitesize: The particle model
This website contains an interactive animation about how the particles in solids, liquids and gases behave.

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4.3 The particle model explains matter

Teacher notes (pages 66–67)

Introducing the topic

The particle model states that particles are always in motion. It also states that particles move faster when heated and more slowly when cooled. This also explains why, when things are heated, they expand and when they are cooled they contract. The effects of this movement can be seen clearly with gases, where contained particles create a force measured as gas pressure and released gases diffuse into the air. The scent of perfume is a good example of diffusion.

Teaching tips: Common misconceptions

- ‘Atoms are hard, like billiard balls.’ (In fact, atoms are the smallest particle that cannot be broken down any further.)
- ‘Atoms are like cells with a membrane and nucleus.’ (In fact, atoms are the smallest particle and cannot contain organelles. In addition, atoms are non-living, whereas cells are living.)

Differentiation

For less able students:

Less able students could draw an illustration of three types of matter – solid, liquid and gas.

For more able students:

More able students could design an experiment that shows the transition between three states of matter – solid, liquid and gas. The most obvious example of this is the transition from ice to water to water vapour.

Additional activity: The particle model of matter

You may like to use role-plays to revise the particle model of matter, using a group of students (or the whole class) to act like particles in a solid, liquid and gas. This is a fun practical activity that can consolidate students’ knowledge about solids, liquids and gases and the movement of particles. To add to this role-play, ask students to include a section where they are cooled or heated to show a decrease and increase in movement.

Additional activity: Modelling atomic behaviour

Students will commonly use atomic model balls, plasticine or lollies to represent atoms. They will use toothpicks to join them into molecules. These are all legitimate items to use.

Additional activity: Mind map

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A mind map can be an effective and visual way for students with low literacy skills to engage with the concepts in this section. A mind map featuring the key words with key linking terms could be completed by students, ensuring that the major concepts have been understood. Key words could include element, atom, compound, solids, liquids, gases and particles.

Going further

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

BBC Bitesize: Behaviour of matter
This website contains an interactive presentation about the behaviours of solids, liquids and gases under different conditions.

4.4 The particle model can explain the properties of matter

Teacher notes (pages 68–69)

Introducing the topic

This topic discusses the physical properties of matter including strength, hardness, viscosity, compressibility and density.

Teaching tips: Properties

Each element or substance exhibits different properties. Properties help us describe and identify a substance and determine what to use and when. Physical properties can be observed or measured without changing the composition of matter. These physical properties make a good starting point for learning about this topic. Students could be encouraged to investigate the physical properties of different elements or substances. They could choose one or two substances or elements and find the properties (boiling point, melting point, strength, hardness etc.) for the substances or elements they choose.

Additional activity: Investigating particle pressure

Air pressure is maintained in a number of places, most commonly in commercial aircraft cabins. This is to maintain a safe and comfortable environment in the low atmospheric pressure outside the aircraft. The human body can only withstand certain atmospheric pressures and, as such, cabin pressurisation is needed. Physiological problems, such as altitude sickness, decompression sickness, hypoxia and barotrauma, may occur if pressurisation is not correct. Students should be encouraged to talk about their experiences in a pressurised cabin. Such things as blocked ears and feeling dizzy and tired are common experiences when flying, due to pressurisation.

Additional activity: Ice-cube necklace

A demonstration of the changing properties of matter could help students grasp the states of liquid, solid and gas. Water is particularly useful for this. Pure water freezes at 0°C and by adding salt the freezing temperature of water is reduced. Salt and other solutes reduce the freezing point because they disrupt the crystal structure of ice and reduce the concentration of pure water. At 0°C, the molecules in pure water form very strong bonds with each other, locking them into position to form a solid. If foreign molecules, such as salt molecules, squeeze between the water molecules, the strong bonds cannot form. Any reduction in the concentration of pure water reduces the freezing point. So the higher the salt concentration, the lower the freezing point. When salt is sprinkled onto an ice cube, the local salt concentration increases and the freezing point lowers. The melting water flows off the cube and flushes some of the salt away, reducing the local concentration on top of the ice

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cube. The lower salt concentration raises the freezing point again so the water refreezes, trapping the string.

Additional activity: Student-designed experiments

Students can design experiments to investigate several aspects of state change. Some possible ideas for these experiments:

- How does change of state affect volume?
- Does pure or salt water freeze faster?
- Does hot or cold water freeze faster?
- Will water evaporate faster than octane?

Going further

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

Changing water
This animation of the changing states of water shows students the many ways in which water can change its state.

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4.5 Increased kinetic energy in matter causes it to expand

Teacher notes (pages 70–71)

Introducing the topic

In this section, students consider how energy can change in particles. When heated, particles move more rapidly; when cooled, they slow down. In a cold drink, the particles have less energy than in a hot drink. In a hot drink, the particles have so much energy that often vapour can be seen rising from a mug – this is because the particles have broken their bonds and become a gas.

Teaching tips: Use of video

This topic can often be best learnt using video and animation. The behaviour of particles is best seen and understood through a visual medium.

Differentiation

For less able students:

Less able students could use a cloze activity to access this text-heavy topic.

For more able students:

More able students could be challenged to design an experiment that shows that hot air expands and cold air contracts. Students could then carry out the experiment. This could be also used as an assessment.

Additional activity: Making a hot-air balloon

Simple, small hot-air balloons can be created and launched at school. A number of templates for this experiment, including important safety instructions, can be found online.

Additional activity: Diffusion of a gas

Use a perfume or air-freshener bottle to demonstrate the diffusion of a gas. You should spray the perfume at the front of the class, and ask the students to raise their hands when they can smell it. This will allow students to visualise the diffusion of the gas throughout the room.

Additional activity: Air pressure

Even though we can't feel it, every person on Earth is constantly being squeezed by the air pressure around us. However, it is balanced by the pressure from inside our bodies, and so we aren't crushed. We can investigate what would happen when we remove the pressure from inside an object by using a soft-drink can. Add a teaspoon of water to an empty soft-drink can, and heat the can over a Bunsen burner. This will convert the water to steam, and reduce the amount of air in the can. Once the water has boiled off, the can should be placed open-side down into a tub of water. This will rapidly cool the steam, resulting in a significant drop in pressure. Consequently, the air pressure from the atmosphere will be stronger than the pressure inside the can, and the can will be crushed.

Additional activity: Models

Students can use toothpicks and plasticine (or similar) to create models of the lattice structure found in solids. They can also model the addition of heat and break them apart to create a liquid model. The particles in liquids can ‘flow’ over each other, which could also be modelled. An accompanying verbal explanation may add value to the task.

Additional activity: Sublimation and deposition

Sublimation and deposition are quite rare changes of state. Students could research which substances and under what circumstances these two processes will occur.

Going further

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

BBC Bitesize: Particle model
This website contains revision on how the particles in solids, liquids and gases behave.

4.6 Atoms and elements make up matter

Teacher notes (pages 72–73)

Introducing the topic

Elements can be arranged into groups depending on their properties. The periodic table is an ordered list of all the elements. Learning how to read and understand the periodic table is a key area of understanding in science.

Teaching tips: Atomic model kits

These are a good way to demonstrate that elements are the building blocks of chemical substances; each element is represented by a different coloured ball. An illustrated poster of the periodic table is useful, too. Interactive periodic tables can be found online. These highlight the different groups of elements, provide specific information about each element and show periods and groups. Pocket-sized periodic tables can also be sourced online and printed out and distributed to students so they always have access to one. The periodic table can be daunting to many students and it does contain a lot of information. It is important that students know what kind of information the table includes. You can discuss the atomic number (at the top), which indicates how many electrons/protons the atom has, and the atomic weight (at the bottom), which is roughly equal to the number of protons and neutrons. The protons and neutrons are found in the nucleus of the atom, giving it nearly all its mass. You can also discuss which elements are naturally occurring and which are artificial.

Teaching tips: Common misconceptions

It might be useful to address common misconceptions at the start of the topic. These are some examples:

- ‘Because water is pure it must be an element.’ (In fact, water is a compound because it contains two elements: hydrogen and oxygen.)
- ‘The periodic table is complex.’ (In fact, it isn’t; it has order and structure.) Many people believe the periodic table is too difficult to memorise. No student should be expected to memorise the periodic table. Rather, students should have access to a copy they can use at any time.

Differentiation

For less able students:

Less able students would benefit from colouring in their own black and white copy of the periodic table, showing each group as a different colour, and the use of video when describing the properties of each group of elements.

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For more able students:

More able students could design and create a memory game that teaches students the first 20 elements of the periodic table. Some examples of this go from the simple, such as flash cards and bingo, to the more complex, such as Periodic Table Battleship.

Additional activity: Adopt an element

Students are required to research an element, create an advertisement and complete an element fact sheet. Many project sheets for 'adopt an element' exist online.

Additional activity: Remembering the periodic table

There are some good games that can be played to assist students with remembering elements from the periodic table. An example of this is Periodic Table Bingo. Periodic Table Bingo gives students a grid of various elements' symbols (e.g. C, K, Na), you then read the name of an element and students must remember the symbol in order to be able to cross it off. There are many free templates for Periodic Table Bingo available online.

Additional activity: The periodic table

Students could research different forms of the periodic table to show that it doesn't just exist in the standard form.

Additional activity: Student-designed experiments

Students can design experiments that test viscosity, conductivity, refractive index, heat capacity or compressibility. An experiment testing compressibility may be easier to design than one on refractive index. Students must write a full experiment report including a testable hypothesis, materials and methods. The best student-designed experiments could be tested by the class.

Additional activity: Conductivity

If time permits, allow students some time to test conductivity using simple circuits. Although students may not have used simple circuits before, they are very easy and safe to use. Students can set up a simple circuit and test the conductivity of various items. They can then see firsthand that some substances are conductors and some are insulators. Suggested items for testing include a strip of aluminium, a nail, a piece of rubber, a piece of fabric, a paper clip and a piece of wood or paddle pop stick.

Going further

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

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Dynamic periodic table

This website contains an interactive version of the periodic table of the elements.

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4.7 Atoms bond together to make molecules and compounds

Teacher notes (pages 74–75)

Introducing the topic

Elements can combine to form compounds and molecules. There are thousands of compounds around us. Compounds have different properties from those of the elements that form them.

Teaching tips: Compounds

Compounds occur when two or more types of element are combined together. An example of this is water – H_2O. Another example is table salt, which is made up of sodium and chlorine (NaCl).

Teaching tips: Mixtures

A good mixture that can be readily examined in the school laboratory is soil. Many of the concepts presented in this section can be explored with the soil sample, for example, why is it a mixture? Is it homogeneous or heterogeneous? A sand sample can be examined, too, if your school is near the beach.

Additional activity: Edible molecules

Students create models of molecules using lollies. By the end of this activity, students should understand that molecules can be either elements (made from the same type of atoms) or compounds (made of two or more different types of atoms).

Materials

- 4 miniature marshmallows (oxygen)
- 7 red gum drops (hydrogen)
- 7 green gum drops (chlorine)
- 2 yellow gum drops (sulfur)
- 25 toothpicks (covalent bonds)

Method

1 Construct models of the following molecules: H_2, HCl, H_2O (Hint: Attach the hydrogen at right angles to the oxygen.)

2 Now construct models of these molecules: Cl_2, H_2S, Cl_2O and Cl_2S.

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3 Classify the molecules as a gas, liquid or solid at room temperature.

4 Draw diagrams of each of the model molecules you have constructed.

5 Compare your models with the actual structure of the molecule.

To extend students, discuss chemical formulas. Students should understand that the chemical formula for a molecule or compound shows the number of each type of atom or element in the molecule. The numbers, written as subscripts, are determined by the bonding between the atoms. In the models constructed, the toothpicks represent the bonds between the atoms.

Additional activity: Writing simple chemical equations

Scientists use symbols to write out chemical equations in place of full words. H_2O is an example of this. Instead of writing out 2 hydrogen and 1 oxygen atoms, H_2O is a faster way of presenting the information.

Give students some small common chemical equations to write out:

Hydrogen and oxygen gases combine to form water.

Magnesium burns in oxygen to form a white powder – magnesium oxide (this can also be done as a practical/experiment in class).

Additional activity: Polymers

To augment this section, you could show students a range of polymer items and ask them to group them into like items. The recycling codes could also be explained and used as a basis for this.

Going further

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

BBC Bitesize: Compounds and mixtures
This website contains a presentation about compounds, elements and mixtures, followed by a short quiz.

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Chapter 4: Sound and light

4.1 Vibrating particles pass on sound

Teacher notes (pages 70–71)

Introducing the chapter

Energy is the unifying theme of this chapter and the next. This chapter takes us on a journey covering the properties of waves, such as light and sound; the next chapter includes the transformation of energy that occurs when we use electricity. It covers the types of energy we encounter every day and how we need to change our use of energy as energy sources change or become harder to access.

This chapter builds upon the teaching from previous year levels, for example, students discuss how scientific understanding and technological developments have contributed to finding solutions to problems involving energy transfers and transformations.

Teaching tip: Frequency

This section introduces two key terms – frequency and hertz. High-frequency sounds have short wavelengths and low-frequency sounds have long wavelengths. Hertz (Hz) is the measurement of frequency.

Teaching tip: Waves

A way to get students to remember the difference between transverse waves and longitudinal (sound) waves is to focus on the vibrations as being across the energy flow and relate the meaning of ‘trans’ to words such as ‘transport’ (carry across). Remind students that longitudinal waves have particles moving in the same direction as the energy.

Teaching tip: Energy

The concept of energy is difficult to communicate to students. The most effective way to introduce the idea of energy is to describe it as the ‘ability to do something’. If there was no energy, then nothing would change. This energy can exist in a variety of forms, all of which allow something to be done, be it due to an object’s height, its chemical make-up, its motion, its temperature or in the way that it is stretched or compressed.

Teaching tip: Glossary

Ask the students to keep a glossary of key words as they work through the chapter. It is a great literacy strategy to help students through the topic. It may be wise to provide a template for students to fill out.

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Teaching tip: Further information

There are many great websites that provide excellent explanations of the concepts covered in this chapter, along with animations and interactives that students will enjoy. They can be used as inquiry tools, where students can discover concepts for themselves through simulations and models, as reinforcement of concepts, or perhaps as alternative sources of information for some students with lower abilities.

Teaching tip: Hands-on learning

It is essential that students complete the hands-on activities in this section because the concepts presented can often be quite abstract without concrete activities. If students make predictions and test them using the equipment, then they have a better chance of understanding.

The movement of the particles in mechanical waves is quite difficult to understand without clear animations or observations. Students can find many animations or videos on the Internet that could assist them and complement the activities in this chapter.

Teaching tip: Ultrasound

Locating objects using reflected sound waves is used in ultrasound imaging. Different image types can be obtained, all using the fact that ultrasound waves (of a frequency higher than the human audible range) partially reflect every time they move through a boundary. In this way, sound waves pass into the body and reflections are detected from the many boundaries (e.g. when they arrive at a foetus's skull). These reflections provide a measurement of distance and these allow for a picture of an internal object to be generated. Technology has advanced from early still images to real-time moving data, which can be surface rendered to provide a realistic 'apparent' image.

Additional activity: Pre-testing

Students will have had some experience with energy from previous years. An official pre-test or general class discussion will highlight prior knowledge and any misconceptions students may have.

Students will hopefully already be comfortable with the basic concept of energy: it cannot be created or destroyed, only transferred or transformed. This chapter focuses more on the transfer of energy rather than transformation, but some students will already be familiar with conduction and convection of heat energy and basic electrical circuit concepts. So, where possible, rather than going back to basic concepts to build up to new knowledge and understanding, encourage confident students to explain the basic concepts.

Going further

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

Physclips – waves and sounds

The UNSW School of Physics website has many animations and a lot of information on all aspects of waves.

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4.2 Sound can travel at different speeds

Teacher notes (pages 72–73)

Introducing the topic

This section focuses on hearing and sound. Sound travels as waves carried by vibrating particles. It travels far more slowly than light. Sound travels faster through solids than liquids and gases.

Teaching tip: Sonar

This method of echolocation is used by bats to navigate and to find food. Locating objects using reflected sound waves is used in ultrasound imaging. Different image types can be obtained, all using the fact that ultrasound waves (of frequency higher that the human audible range) partially reflect every time they move through a boundary. In this way, sound waves pass into the body and reflections are detected from the many boundaries (e.g. when they arrive at a foetus's skull). These reflections provide a measurement of distance and these allow for a picture of an internal object to be generated. Technology has advanced from early still images to real-time moving data which can be surface rendered to provide a realistic 'apparent' image.

Teaching tip: Sounds of silence

Different methods of sound insulation rely on the basic premise of preventing the passage of sound. Sound can be absorbed in curtains and carpets, wall and windows, especially double-glazed windows. Every time sound passes to a new material, some of it will be absorbed.

Another place where sound travel must be controlled is in auditoriums, where the reflection of sound produces unwelcome echoes and a distortion of the music or speech. In this case, the priority is to stop reflection, usually by using soft materials to absorb it or uneven surfaces, which break up the sound waves and prevent the wave being reflected all at once.

Decibels are the units used to describe sound levels. A sound of 20 dB will not sound twice as loud as 10 dB (it will in fact be about 10 times louder).

Teaching tip: Effects of helium

The idea of different frequencies sounding different could be expanded to include the observation of what happens when people breathe in helium gas. Most students will have witnessed this squeakiness of a person's voice. This happens because the helium changes the speed of sound between our vocal chords and the frequency of the sound produced.

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Differentiation

For less able students:

Focus on more practical activities, such as the continued use of the springs as models of waves, which would be useful to reinforce understanding.

For more able students:

Students could analyse graphs of particle motion for different types of waves to determine the properties of the waves and describe the motion of the particles.

Additional activity: Seeing sound

Connect a microphone to a cathode ray oscilloscope and ask students to whistle or speak into the microphone. If set up correctly, there will be a waveform on the screen. Different musical instruments can be used to compare the 'purity' or smoothness of the trace. It is possible to produce a very smooth waveform by whistling if the pitch is maintained. The process of taking in sound and changing the information into an electrical signal can be compared to the function of our ears. It is worth mentioning that most smartphones now have oscilloscope apps that can be downloaded for free.

Additional activity: How we use sonar

Students may not realise how many human applications of sonar there are. Further research may be useful to enhance their understanding. Students could work in pairs and then share their findings with the rest of the class.

Additional activity: Sound through solids

It's quite simple to demonstrate how well sounds travel through solids as opposed to air. One student should lay with their head against the desk. Another student will then scratch the underside of the desk with their fingernails. This sound should be very clear. If the first student now sits up straight and the scratching is repeated, the sound will be much more difficult to hear.

Going further

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

Dangerous decibels

This website lists permissible decibel exposure times.

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4.3 Our ears hear sound

Teacher notes (pages 74–75)

Introducing the topic

This section explores how our ears hear sound. The parts of the ear are explored and their roles explained. The ear is a highly sensitive and accurate system for detecting sounds and then relaying this to the brain for processing.

Teaching tip: Hearing

It is well worth using a biological model to explore the middle ear. Alternatively, there are some useful animations online.

The transfer of energy between the outer world via the ear to our brains can be examined to explore the many types of energy and also the notion of ‘hearing’. Sound energy is changed to movement energy (kinetic energy) within the eardrum and ossicles, then to electrical energy passed along the auditory nerve. This means that what we ‘hear’ happening in the outside world is communicated to our brains as little electrical pulses.

This can be compared with the recording of music into a digital format, such as an MP3 file. This can open the debate of whether we all hear the same thing – the electrical signals produced in different ears may not all be the same.

There is significant conceptual content within this topic and it always pays to engage the students at the outset.

Additional activity: Travelling sound energy

Students should line up equally spaced across an oval. A starting pistol (or anything that produces a sharp loud noise) should be fired at one end and students instructed to raise their hands when they hear it. This should produce a wave as hands are raised along the line.

Additional activity: Range of hearing

Use a sound generator to produce a loud tone at 20 Hz. Increase this gradually, and at about 3000 Hz there will be a perception of a louder tone (due to resonance within the ear canal). More interestingly, at about 18 000 Hz an adult stops hearing the tone, but younger students can detect the sound to around 20 000 Hz. Links to mosquito ring tones can be made here.

Additional activity: Researching sound

There is a huge range of different applications of sound in real life. The UNSW School of Physics website has excellent resources about some of these applications of waves and sound. Students could choose a topic based on the information available on the website and produce an informative poster or presentation about their chosen topic.

Going further

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

Physclips – waves and sounds in real life

Students can research sound and waves in real life at the UNSW School of Physics website.

4.4 Things can go wrong with our hearing

Teacher notes (pages 76–77)

Introducing the topic

Your hearing relies on very thin layers of skin in the eardrum, small bones in the middle ear, and fine hairs in the cochlea. These delicate mechanisms can become damaged by loud noises, infections or age.

Teaching tip: Important scientists

An Australian scientist Professor Graeme Clark and his team at the University of Melbourne developed the cochlear implant, changing the lives of many hearing-impaired people all around the world. This example is a great way to discuss careers in science with young people. What other breakthroughs have occurred? What areas of science are there? What kinds of jobs in science are likely to be available in the next 20 years? How have scientific breakthroughs changed people's lives?

Differentiation

For less able students:

Ask students to investigate why their sense of balance is altered when they have problems with their ears.

For more able students:

Students could research why many doctors suggest that you rarely or never clean your ears. Why is earwax so important? What role does it play in maintaining a healthy ear? This information could be presented to the rest of the class and discussed.

Additional activity: What is a bionic ear?

Students could consider how scientists know what electronic signals to send through to the auditory nerve and whether other bionic devices are used or could be developed to help visual impairment or nerve damage.

Additional activity: Tinnitus

Ask students to research what can be done for sufferers of tinnitus. Tinnitus is a complicated disorder with many people experiencing different symptoms that impact enormously on their lives.

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Going further

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

BBC – hearing

The BBC website contains information and an animation that explains how our hearing works.

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4.5 Visible light is a small part of the electromagnetic spectrum

Teacher notes (pages 78–79)

Introducing the topic

The electromagnetic spectrum is a way of describing all the forms of light, including the light we see. This section gives well-known examples that rely on radiation waves, light, infrared radiation and x-rays.

Teaching tip: Electromagnetic spectrum

Students should know the general location of the different types of electromagnetic radiation on the spectrum, the trends that occur along the spectrum and the uses of each section. Familiar examples include microwave ovens, mobile phones, tanning beds and remote controls. Students can then indicate the trends of the wavelength, frequency and energy along the electromagnetic spectrum and relate these to their uses. For example, gamma rays are high energy because they have a high frequency (according to $E = hf$) and have a relatively short wavelength, so they can pass through our bodies quite easily. They are able to deliver a high amount of energy if given in large doses and are therefore useful in treating some cancers by killing the target cells.

Teaching tip: Electromagnetic radiation

It is useful for students to explore practical examples of electromagnetic radiation in the laboratory or at least discuss and list examples they are familiar with.

Electromagnetic radiation can be quite abstract. If students have not experienced an electric and magnetic field adequately before, they will struggle with a basic understanding of what a light wave is.

It is best if students explore some different examples of electromagnetic waves, such as these examples:

- detecting some radio waves with a radio
- blocking the signal to their mobile phones with a Faraday cage
- making the infrared radiation from a remote control visible using a video camera

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Differentiation

For less able students:

A modelling activity using their hands as parts of an electromagnetic wave is useful to help students understand what it is. One hand is the electric field and the other is the magnetic field.

For more able students:

Introduce the equation $E = hf$ to illustrate the connection between the frequency and energy of the radiation.

Additional activity: Jigsaw

The content in this section can easily be taught as a jigsaw activity, where students are organised into groups of six. Each student in the group is then allocated one of the main types of waves on the electromagnetic spectrum. All students with the same electromagnetic wave gather together and become experts in that wave. They then return to their original group and report back on their wave. Students can share notes and construct a graphic organiser to collate all the information.

Going further

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

What is a wave?

This website uses animations to show the difference between longitudinal and transverse waves.

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4.6 Light reflects off a mirror

Teacher notes (pages 80–81)

Introducing the topic

This section looks at how light travels and how it interacts with objects. Lights can travel through transparent objects and is blocked by opaque objects. Translucent objects allow some light energy through. Light always follows particular rules when it reflects from a surface – the normal, angle of incidence and angle of reflection are explored.

Differentiation

For less able students:

Students could be asked to find examples of transparent materials, translucent materials and opaque materials. This could be a challenge set in the room or school with a time limit whereby teams race to list the most of each.

For more able students:

Students could draw an image of themselves in a convex mirror and a concave mirror. These images must then be annotated to demonstrate their knowledge of how light is acting in order to produce the image.

Additional activity: Locating the image

Ask students to place an object in front of a plane mirror on top of a sheet of paper (thin objects such as pencils work well). Students now trace a line from their viewpoint to the image of the object in the mirror. Students should then change their point of view and repeat. Once this has been done a few times, remove the mirror, and extrapolate the lines until they converge on a point behind where the mirror was. If done correctly, the point of convergence should be exactly the same distance from the mirror as the original object was, but in the opposite direction. This demonstrates an important law of reflection – that an object and its reflection are both equidistant from a mirror. This can also be shown by looking into a mirror – in this case the “you” on the other side of the mirror will be the same distance as you are from your side of the mirror.

Additional activity: Modelling reflection

Students can easily model reflection using a bouncy ball and a hard surface. Get students to predict where the ball will bounce when it strikes the surface at different angles.

This can be a good way to encourage students to create a testable hypothesis. As an extension activity, students should explain their hypothesis using scientific reasoning.

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Going further

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

General properties of waves – reflection

The BBC Bitesize website gives more information about the general properties of waves and in particular, reflection.

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4.7 Light refracts when moving in and out of substances

Teacher notes (pages 82–83)

Introducing the topic

Refraction is the bending of light as it enters or leaves a denser material at an angle. Shiny surfaces cause reflection, but when light strikes a transparent material it enters the material and may change direction. Refraction makes underwater objects appear closer to the surface than they really are.

Teaching tip: Reflections

Students can recall their observations of slinky springs where they would have observed reflections of the pulses that went along them. As an example of an inquiry approach in the classroom, students could perform a modified version of Challenge 4.5 and discover the law of reflection themselves before to being introduced to it as a theoretical concept.

Drawing diagrams to illustrate the colours of light reflected and absorbed from a coloured object can be a good way to get students to understand what is occurring. This is often done using diagrams such as those shown in Figure 4.25 on page 85, where the colour absorbed is missing in the colours reflected. Asking students to explain why objects they are familiar with are certain colours can also be useful (e.g. Why do plants appear to be green?).

Differentiation

For less able students:

Refraction can cause difficulties for lower-ability students if they are required to remember the rules about the direction of refraction of light. It is much easier for students to apply a simple physical model, such as the wheels of a truck travelling into mud. This model can be applied to light as long as students know the relative speed that light travels in two different media. It allows them to predict the direction of refraction without remembering rote-learned rules or mnemonics. It would therefore be necessary to rank common materials according to the speed that light travels within them.

For more able students:

Snell's law could be introduced. Snell's law shows the relationship for a ray of light being refracted as it passes from one medium to another. Snell's law is $\frac{\sin i}{\sin r} = \frac{v_1}{v_2} = \frac{n_2}{n_1}$, where i is the angle of incidence, r is the angle of refraction, v_1 is the velocity of the incident ray, v_2 is the velocity of the refracted ray, n_1 is the refractive index of the first medium and n_2 is the refractive index of the second medium.

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Additional activity: Modelling light waves

Light travels as a transverse wave, which means its behaviour can be modelled using water waves. A shallow tank with a large surface area is ideal. Dropping an object into the water at one end will generate waves (ripples) that will spread across the tank. Multiple objects can be dropped into the tank to see how waves interfere with each other, or a solid surface can be angled across the tank to observe reflection. It is important to make the distinction between light and water, in that the water waves will spread in concentric circles around the point of disturbance, whereas light travels in straight lines.

Going further

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

Bending light

This website has an interactive that demonstrates the bending of light between two media with different indices of refraction. A plane boundary or different shapes are possible.

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4.8 Different wavelengths of light are different colours

Teacher notes (pages 84–85)

Introducing the topic

This section introduces students to the nature of visible light. White light is comprised of all the different colours of light and can be separated using a prism. The colours we observe depend on the colours being reflected from objects that we see. For example, an apple will appear green if it reflects green light and absorbs all other colours.

Teaching tip: Dispersion

Students are often confused by the concepts of dispersion. It is the change in speed of each of the frequencies of light within the medium that causes dispersion. Light with different frequencies travels at different speeds within the medium. The wavelength of light changes when the speed changes, but the frequency stays the same (i.e. the frequency is what gives the components of white light their colours).

Teaching tip: Waves

A way to get students to remember the difference between transverse waves and longitudinal (sound) waves is to focus on the vibrations as being across the energy flow and relate the meaning of ‘trans’ to words such as ‘transport’ (carry across). Remind students that longitudinal waves have particles moving in the same direction as the energy.

Differentiation

For less able students:

Give students coloured filters to observe different coloured objects. By doing this they will notice that a red object will appear black if looked at with a green filter. This is because the red object will only reflect red light but the green filter will only allow the transmission of green light, making the object appear black as no red light will get through.

For more able students:

Challenge students to match different colours of light with their respective wavelengths.

Additional activity: Introducing rainbows and dispersal

A nice way to introduce the colours of the rainbow is to make one. Disperse sunlight into a darkened room using a glass prism to create a dramatic demonstration. With practice, you can place a large spectrum on the wall or roof and students can observe the colours.

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Going further

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

Dispersion of light by prisms

The Physics Classroom website has an extensive explanation about the dispersion of light by prisms.

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4.9 The electromagnetic spectrum has many uses

Teacher notes (pages 86–87)

Introducing the topic

When a light ray passes into a less dense medium at a particularly large angle, it can be reflected back into the dense medium. This called total internal reflection. This characteristic of light is used in optic fibres. This section also explores other forms of the electromagnetic spectrum, such as microwaves.

Teaching tip: Optic fibres

Light is not the physical movement of mass, so there is very little energy loss as light travels though a transparent material. Because light beams can pass through other light beams without being affected, there is no limit to how many telephone conversations could be passed down a fibre at once. When we rely on electrical energy to communicate, there is the issue of interference because all current will generate magnetic forces that affect other currents. Students may be familiar with image problems on their televisions when other electrical devices are operating nearby.

Additional activity: Energy and safety

With reference to an electromagnetic spectrum, a class discussion could help determine where the most dangerous types of radiation are found (generally, the shorter the wavelength, the more damaging the radiation is). Students could then brainstorm ways of protecting ourselves from these types of radiation. Some will be obvious, such as lead shielding for x-rays. Others will be less so, such as the mesh on a microwave door being too small to allow the larger wavelength microwaves to transmit.

Additional activity: See, Know, Wonder

See, Know, Wonder activities always involve a visual cue like a photo or video. Give students an image to consider, for example, an extremely detailed CT scan of a human skull. Students draw a three-column table and start by working individually, listing three things that they can see in the image, for example, the crevices in the skull. They then complete the column for Know – what do they know when they look at the image? For example, I know that this is a human skull. The final column is Wonder – what does the image make them wonder? For example, is anything wrong with this person? Why are they getting a CT scan? Students then pair up and, in a different coloured pen, add any See, Know, Wonder points that their partner had that were different from their own. This comparison can be repeated in different pairs or even among the whole class. See, Know, Wonder activities help students to develop observational skills as well as questioning and working with others.

Additional activity: Transforming devices

As a class, students could brainstorm a list of devices that convert one type of energy to another, and what the energy conversion is (e.g. a radio converts electrical energy to sound energy). Once a good-sized list has been created, the class should look for patterns (e.g. light and sound energy are usually outputs).

Going further

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

The scale of the universe

This website allows students to visualise the size of a large number of things, including the wavelength of different electromagnetic radiation types.

4.10 Our eyes detect light

Teacher notes (pages 88–89)

Introducing the topic

Our eyes are amazing organs. They automatically control how much light enters, enabling us to see in both dim and bright conditions. A lens focuses the light onto the back of the eye. The light receptors detect light and send a message to the brain, which then forms a picture.

Teaching tip: The eyes

Similarities can be drawn between the function of the eye and the ear. They both work as external sensors to convert information/energy into electrical signals for the brain to process. Students could consider how a bionic eye may function and compare the processes to the bionic ear. Could other senses be simulated in this way? This will be investigated later in the chapter.

A simple model of the function of the eye can be constructed, using a conical flask and a plano-convex lens. Fill the flask with a slightly opaque liquid (cordial will work) and shine a lamp from a ray box into one side of the flask. The beam of light will be affected by the fluid, as occurs in the eye.

By adding the plano-convex lens to the side of the flask where the light enters, the path of the beam can be focused onto the back of the flask. This models the role of the eye's lens. The lens's focal length should approximate the diameter of the flask, but the fluid in the flask itself will act as an extra lens.

Teaching tip: Pupils

Pupils allow light to enter the retina. They appear black because other tissues in the eye absorb most of the light entering the pupil. The iris regulates the amount of light entering the eye by controlling the size of the pupil. When bright light is shone on the eye, light-sensitive cells in the retina send messages to the parasympathetic division of the eye and the muscles contract, causing the pupils to contract. Conversely, when there is less light, messages are sent to the sympathetic division of the eye and the muscles relax, causing the pupils to dilate. Pupils will also dilate if a person sees an object of interest.

Differentiation

For less able students:

It may be beneficial for students to practise labelling the parts of the eye on a worksheet with a diagram similar to the one on page 88.

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For more able students:

Students could choose three animals and compare their eyesight to human eyesight. How does the world look to them? As an extension, they could explain why the vision of each is different from a human's vision.

Additional activity: Parts of the eye

Students could complete a table like the one below (which also includes suggested responses), describing the role of each of the parts of the eye.

Part of the eye	Role
Retina	Converts light signals to electrical signals
Iris	Controls intensity of light entering the eye
Pupil	Opens to allow light into the eye
Cornea	Transparent front section that initially bends light
Optic nerve	Connects retina to brain to convey electrical signals
Vitreous humour	Holds eye shape and permits light through to retina
Sclera	Outer protective surface of the eye
Lens	Focuses light onto retina
Ciliary muscle	Controls shape of lens
Aqueous humour	Provides nourishment for the cornea and lens

Going further

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

Sight

This BBC web page contains information and an animation that explains how our eyesight works.

4.11 Things can go wrong with our eyes

Teacher notes (pages 90–91)

Introducing the topic

There are many problems that students will be familiar with, and may even have themselves. Some people find it hard to focus their vision on close or distant objects. Other people may have an eye that is misshapen. Some problems can be fixed with corrective lens whereas others may require surgery.

Teaching tip: Colour-blindness

Some students in the room may inquire about colour-blindness and it may be worth explaining how the cones in the eye vary. A typical colour-blindness is red-green colour-blindness, an inherited condition in which the cone that detects red light does not function.

Additional activity: Testing for colour-blindness

There is a large number of websites available featuring tests for colour perception and colour blindness. Students may enjoy trying these – there are also similar tests on YouTube.

Additional activity: Class discussion

Canvass the class to see who is long- or short-sighted and encourage them to explain what is meant by this – often a student's account is easier to digest. An expansion of this discussion can cover how the ciliary muscles control the thickness of the lens, but where help is needed, additional lenses 'pre-bend' the light to allow it to focus. As we age, these muscles can lose their strength; however, many people believe that these muscles can be strengthened by specific exercises. If possible, examine the lens shape of long- and short-sighted students' glasses to compare their function.

The size of the pupil can visibly change as light increases or decreases, and this is easy to replicate using low-power lamps in a dark room. If time permits, constrict pinhole cameras to show the effect of aperture (pupil) size and effective or ineffective lenses.

Additional activity: The bionic eye

Scientists are currently working on a bionic eye that may be trialled in a few years' time. Students could further research the bionic eye, explaining how it would work and where it is being created.

Going further

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

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The blind spot

This website has a number of vision tests for young people to try.

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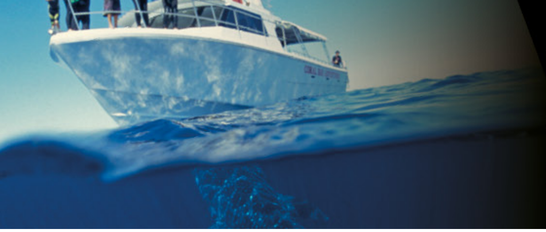

Suggested teaching program

Chapter 4: Sound and light

Time allocation: 6 weeks

Context and overview
In year 9, students begin to develop a more sophisticated view of energy transfer. Students formulate hypotheses and analyse data to draw and evaluate conclusions using primary and secondary sourced evidence.
Syllabus outcomes addressed
• Energy transfer through different mediums can be explained using wave and particle models ACSSU182 • Scientific understanding, including models and theories, is contestable and is refined over time through a process of review by the scientific community ACSHE157 • Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries ACSHE158 • People use scientific knowledge to evaluate whether they accept claims, explanations or predictions, and advances in science can affect people's lives, including generating new career opportunities ACSHE160 • Values and needs of contemporary society can influence the focus of scientific research ACSHE228 • Plan, select and use appropriate investigation types, including field work and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods ACSIS165 • Select and use appropriate equipment, including digital technologies, to collect and record data systematically and accurately ACSIS166 • Analyse patterns and trends in data, including describing relationships between variables and identifying inconsistencies ACSIS169 • Use knowledge of scientific concepts to draw conclusions that are consistent with evidence ACSIS170 • Evaluate conclusions, including identifying sources of uncertainty and possible alternative explanations, and describe specific ways to improve the quality of the data ACSIS171 • Critically analyse the validity of information in primary and secondary sources and evaluate the approaches used to solve problems ACSIS172 • Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations ACSIS174
Achievement standards
Students describe models of energy transfer and apply these to explain phenomena. Students describe social and technological factors that have influenced scientific developments and predict how future applications of science and technology may affect people's lives. Students design questions that can be investigated using a range of inquiry skills. They design methods that include the control and accurate measurement of variables and systematic collection of data and describe how they considered ethics and safety. They analyse trends in data, identify relationships between variables and reveal inconsistencies in results. They analyse their methods and the quality of their data, and explain specific actions to improve the quality of their evidence. They evaluate others' methods and explanations from a scientific perspective and use appropriate language and representations when communicating their findings and ideas to specific audiences.

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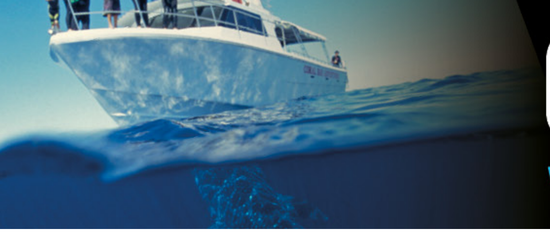

Student book section	WA Syllabus links	Suggested indicators of learning and understanding	Suggested teaching and learning activities	Resources
4.1 Vibrating particles pass on sound **(pages 70–71)**	*Science Understanding* ACSSU182 *Science as a Human Endeavour* ACSHE157 *Science Inquiry Skills* ACSIS165 ACSIS170 ACSIS174	By the end of this unit, students should be able to: • Define compression, rarefaction, longitudinal wave, amplitude, wavelength, frequency and hertz • Describe the motion of molecules in a longitudinal wave • Relate wavelength to frequency and pitch	**What if?** Students investigate the transference of sound through a medium (string phone). **Challenge 4.1** *Modelling sound waves* Students model compressions and rarefactions of a longitudinal wave using a slinky. **Properties of sound** Students can learn more about the main properties of sound; frequency, pitch and timbre, and longitudinal waves by watching the UNSW clips.	**Oxford Science 9 Western Australian Curriculum resources** • What if? Page 69 • Check your learning, page 71 • Challenge 4.1, page 193 **Additional resources** UNSW Physclips – Sound: http://www.animations.physics.unsw.edu.au/waves-sound/sound/index.html - 4.1 Properties of sound - 4.2 Longitudinal waves
4.2 Sound can travel at different speeds **(pages 72–73)**	*Science Understanding* ACSSU182 *Science Inquiry Skills* ACSIS165 ACSIS166 ACSIS169 ACSIS170 ACSIS172 ACSIS174	By the end of this unit, students should be able to: • Explain why sound does not travel through space • Relate the transmission of sound to the density of particles of the medium through which it travels	**Challenge 2.4A** *The speed of sound* Students investigate the speed of sound and consider the reliability of data. **Challenge 2.4B** *Racing dominoes* Students model the differences in the speed of sound in different mediums using dominoes. **The speed of sound** Students can see a demonstration of the difference in the speeds of light and sound and a demonstration of how to calculate the speed of sound by watching the UNSW clip.	**Oxford Science 9 Western Australian Curriculum resources** • Check your learning, page 73 • Challenge 2.4A, page 194 • Challenge 2.4B, page 194 **Additional resources** UNSW Physclips – Sound: http://www.animations.physics.unsw.edu.au/waves-sound/sound/index.html - 4.5 Speed of sound

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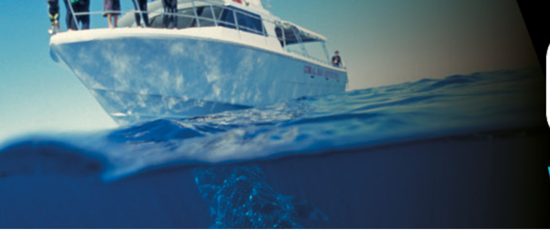

4.3 Our ears hear sound **(pages 74–75)**	*Science Understanding* ACSSU182 *Science as a Human Endeavour* ACSHE157 *Science Inquiry Skills* ACSIS165 ACSIS170 ACSIS174	By the end of this unit, students should be able to: • Identify the key structures of the ear and describe their function in detecting sound • Describe the processes involved in the detection of sound	**Experiment 4.3** *Why do we need ears?* Students investigate the purpose of two ears. **Structure and function of the ear** Students can investigate the specific structures and their functions within the human ear with the Interactive Ear website.	**Oxford Science 9 Western Australian Curriculum resources** • Check your learning, page 75 • Experiment 4.3, page 195 **Additional resources** The Interactive Ear: http://www.amplifon.co.uk/interactive-ear/index.html
4.4 Things can go wrong with our hearing **(pages 76–77)**	*Science Understanding* ACSSU182 *Science as a Human Endeavour* ACSHE158 ACSHE228 *Science Inquiry Skills* ACSIS165 ACSIS166 ACSIS169 ACSIS170 ACSIS174	By the end of this unit, students should be able to: • Define decibels • Describe the symptoms of tinnitus • Explain the purpose of a cochlear implant • Relate technological and scientific developments with the needs of society	**Challenge 4.4** *Is school bad for your health?* Students investigate sound pollution at school. **Tinnitus** Students can investigate tinnitus in Australia, some of its causes and listen to representations of the symptoms and the Australian Tinnitus Association website. **The history of cochlear implants** Students can investigate the development of cochlear implants using the Time Toast website and create a scale model of the timeline. Encourage students to relate technological and scientific developments.	**Oxford Science 9 Western Australian Curriculum resources** • Extend your understanding, page 77 • Challenge 4.4, page 196 **Additional resources** Australian Tinnitus Association: http://www.tinnitus.asn.au/tinnitus.htm Time Toast – History of Cochlear Implants: https://www.timetoast.com/timelines/history-of-cochlear-implants

4.5 Visible light is a small part of the electromagnetic spectrum **(pages 78–79)**	*Science Understanding* ACSSU182 *Science as a Human Endeavour* ACSHE157 ACSHE158 *Science Inquiry Skills* ACSIS165 ACSIS170 ACSIS174	By the end of this unit, students should be able to: • Define transverse waves • Describe the motion of particles in a transverse waves • List the classes of electromagnetic radiation and their average wavelengths • Explain how light behaves as a wave and how it behaves as a particle	**Challenge 4.5** *Modelling light waves* Students model transverse waves with a slinky considering wavelength, frequency and amplitude. **The speed of light** Students can investigate how to measure the speed of light by watching the experiment on the UNSW clip.	**Oxford Science 9 Western Australian Curriculum resources** • Check your learning, page 79 • Challenge 4.5, page 196 **Additional resources** UNSW Physclips – The nature of light of light: http://www.animations.physics.unsw.edu.au/light/nature-of-light/ - 1.3 The speed of light
4.6 Light reflects off a mirror **(pages 80–81)**	*Science Understanding* ACSSU182 *Science as a Human Endeavour* ACSHE157 *Science Inquiry Skills* ACSIS165 ACSIS166 ACSIS169 ACSIS170 ACSIS171 ACSIS174	By the end of this unit, students should be able to: • Define transparent, translucent, opaque, image, mirror, normal, angle of incidence, angle of reflection, virtual image, convex and concave • Describe the relationship between the angle of incidence, normal and angle of reflection • Describe the characteristics of a virtual image • Demonstrate appropriate use of a Hodson light box • Calculate the angle of reflection from the angle of incidence	**Skills Lab 4.6** *Using a Hodson light box* Students develop skills to use a Hodson light box and to draw ray diagrams. **Experiment 4.6** *Reflection from plane mirrors* Students investigate the law of reflection using a Hodson light box and ray diagrams. **Challenge 4.6A** *Mirror writing* Students investigate perception of reflected light through a number of activities involving the use of a mirror. **Challenge 4.6B** *Using curve mirrors* Students investigate reflection in concave and convex mirrors using a Hodson light box.	**Oxford Science 9 Western Australian Curriculum resources** • Check your learning, page 81 • Experiment 4.6, page 198 • Challenge 4.6A, page 198 • Challenge 4.6B, page 199 • Skills Lab 4.6, page 197 **Additional resources** UNSW Physclips – Mirrors and images: http://www.animations.physics.unsw.edu.au/jw/light/mirrors-and-images.htm

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			Mirrors and images Student can learn more about reflection in different types of mirrors and the differences between virtual and real images in the UNSW webpage.	
4.7 Light refracts when moving in and out of substances **(pages 82–83)**	*Science Understanding* ACSSU182 *Science as a Human Endeavour* ACSHE157 *Science Inquiry Skills* ACSIS165 ACSIS166 ACSIS169 ACSIS170 ACSIS171 ACSIS172 ACSIS174	By the end of this unit, students should be able to: • Define refraction, medium, refractive index, refracted ray, angle of refraction, lens, converge, focus, focal length, diverge and virtual focus • Describe the refraction of light through a convex and concave lens • Explain the difference between focus and virtual focus • Relate the direction of refraction to the change in density of mediums • Demonstrate appropriate use of a Hodson light box	**Experiment 4.7A** *Bending of light* Students investigate refraction of light through Perspex blocks using a Hodson light box. **Experiment 4.7B** *Creating images with convex lenses* Students investigate refraction of light through a convex lens and consider the variable of focal length.	**Oxford Science 9 Western Australian Curriculum resources** • Check your learning, page 83 • Experiment 4.7A, page 199 • Experiment 4.7B, page 200

4.8 Different wavelength of light are different colours **(pages 84–85)**	*Science Understanding* ACSSU182 *Science as a Human Endeavour* ACSHE157 ACSHE158 *Science Inquiry Skills* ACSIS165 ACSIS166 ACSIS170 ACSIS171 ACSIS172 ACSIS174	By the end of this unit, students should be able to: • Define visible spectrum, dispersion, primary colours of light, secondary colours of light, filters and transmit • Describe how we see the colour of opaque and transparent objects • Relate the secondary colours of light to the primary colours of light • Demonstrate appropriate use of a Hodson light box	**Experiment 4.8** *What colour is it?* Students investigate the different colours of light, both primary and secondary, using coloured filters and a Hodson light box. **Colour Vision Simulator** Students can investigate how humans perceive colour with the PHET simulator. Students can alter the colour of the light source, number of light sources, filters and intensity of the light to see how it is perceived.	**Oxford Science 9 Western Australian Curriculum resources** • Check your learning, page 85 • Experiment 4.8, page 201 **Additional resources** PHET Colour Vision simulator: https://phet.colorado.edu/sims/html/color-vision/latest/color-vision_en.html
4.9 The electromagnetic spectrum has many uses **(pages 86–87)**	*Science Understanding* ACSSU182 *Science as a Human Endeavour* ACSHE158 ACSHE160 ACSHE228 *Science Inquiry Skills* ACSIS165 ACSIS166 ACSIS170 ACSIS172 ACSIS174	By the end of this unit, students should be able to: • Define critical angle, total internal reflection and optic fibre • Describe how optic fibres and microwave ovens work • Relate the critical angle with total internal reflection	**Experiment 4.9** *What is the wavelength of a microwave?* Students investigate the wavelength of microwaves. **Using the electromagnetic spectrum** Students can investigate some of the uses for the other classes of radiation on the electromagnetic spectrum including gamma rays, X-rays, ultraviolet light, infrared light and radio waves. Students can work in small groups and present their findings to the class.	**Oxford Science 9 Western Australian Curriculum resources** • Extend your understanding, page 87 • Experiment 4.9, page 202

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4.10 Our eyes detect light **(pages 88–89)**	*Science Understanding* ACSSU182 *Science Inquiry Skills* ACSIS165 ACSIS166 ACSIS170 ACSIS174	By the end of this unit, students should be able to: • Define pupil, cornea, lens, retina and optic nerve • Identify the main structures of the human eye and describe their functions • Explain how an image forms on the retina	**Challenge 4.10** *Vision tests* Students investigate the function of the human eye, including focal length, depth perception and blind spots, through a number of activities. **Experiment 4.10** *Eye dissection* Students develop their dissection skills and investigate the structure of a mammalian eye. **The eye as a lens** Students can compares the function of the eye with a camera and learn more about how the eye refracts light to form an image on the retina. **Extension – Rods and cones** Students can learn more about how the eye detects wavelength and intensity of light using photoreceptors.	**Oxford Science 9 Western Australian Curriculum resources** • Check your learning, page 89 • Experiment 4.10, page 204 • Challenge 4.10, page 203 **Additional resources** UNSW Physclips – The eye and colour vision: http://www.animations.physics.unsw.edu.au/light/eye-colour-vision/ - 3.1 Anatomy and function - 3.2 Retina, rods and cones
4.11 things can go wrong with our eyes **(pages 90–91)**	*Science Understanding* ACSSU182 *Science as a Human Endeavour* ACSHE158 ACSHE228 *Science Inquiry Skills* ACSIS165 ACSIS170 ACSIS174	By the end of this unit, students should be able to: • Define short-sighted, myopia, long-sighted, hyperopia, colour-blindness, cataracts and astigmatism • Provide examples of disease and problems that affect the eyes and vision • Explain how short- and long-sightedness can be corrected with lenses • Relate colour-blindness to the function of photoreceptors	**Challenge 4.11** *Make a jelly lens for your smartphone* Students apply their understanding of the behaviour of light to produce a lens for their phone camera. **Corrective lenses in action** Students can investigate how corrective lenses work on different eye conditions with the comparative animations at the Zeiss website.	**Oxford Science 9 Western Australian Curriculum resources** • Extend your understanding, page 91 • Challenge 4.11, page 205 **Additional resources** Zeiss Vision Animations: http://www.zeiss.com/vision-care/en_de/better-vision/zeiss-spectacle-lens-guide/vision-animations/eye-vision.html

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4 Review **(pages 92–94)**	*Science Understanding* ACSSU182 *Science Inquiry Skills* ACSIS174	By the end of this unit, students should be able to: • Define all Key Words listed on page 94 • Explain the transfer of energy through different mediums using wave and particle models • Identify areas of personal strengths and weaknesses in their knowledge and understanding of the topic	**Revision activities** • Students could play celebrity heads with the Key Words list • Students can make dominoes with Key Words on one end and definitions/diagrams/examples on the other end • Students can create mind maps, Venn diagrams or other graphic organisers to summarise the key concepts of this chapter • Peer teaching: students can work in groups to reteach the content of the unit to the class for the purpose of revision. Each group could be allocated a double-page to summarise	**Oxford Science 9 Western Australian Curriculum resources** • Review questions, pages 92-93 • Research topics, page 93 • Key Words list, page 94

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Chapter 4: Chemical reactions

Pages 89–110

Teacher notes

Introducing the chapter

In Year 9, students studied chemical reactions in terms of the rearrangement of atoms to form new products. Combustion reactions and acid reactions were studied in relation to the Law of Conservation of Mass. This chapter extends this understanding to examine the changes that occur to chemicals as they interact with each other and how this can be used in a range of situations, such as the production of metals, polymers and pharmaceuticals. Future applications, such as aspects of nanotechnology, are also examined. By understanding the types of reactions occurring, the products and the rate at which they are formed can be controlled. The potential hazards of using chemicals are examined in relation to their effects on surrounding systems.

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Teacher notes

4.1 Synthesis and decomposition reactions can be represented by equations

Pages 90–91

Teaching tip: simplified chemical equations

Many of the reactions covered in this chapter can be written in a general form. This may help students to better visualise these reactions in a simplified way.

Synthesis

$A + B \rightarrow AB$

Decomposition

$AB \rightarrow A + B$

Teaching tip: terminology

Although it is not explicitly stated in the student book, it is beneficial to students that they are taught (with examples) that synthesis and decomposition reaction can be labelled as single displacement and double displacement reactions.

Teaching tip: differentiation for advanced students

Whilst many students will accept that decomposition reactions are a type of reaction, more advanced students will ask why the reactions do not occur all the time. Decomposition reactions can be broken into three main types.

- In catalytic decomposition reactions, the reactant will readily break apart and the rate can be increased with the use of a catalyst.
- An electrolytic decomposition requires the use of an electrical current to provide the energy to initiate the reaction.
- In thermal decomposition, direct heat or radiation is used to initiate the reaction.

Irrespective of the initiating factor for the decomposition reaction, energy is always exchanged as a result.

Teaching tip: practice

Students often have difficult with generating balanced chemical equations and so it is best to give them as much opportunity as possible to practise, as it is an essential VCE Chemistry concept.

Follow the 'Gradual Release of Responsibility Model'. Sometimes referred to as 'I do it, we do it, you do it,' this model proposes a plan of instruction that includes demonstration, prompt, and practice.

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Additional activity: flowchart

The production of aluminium can be broken into a series of steps that students can cut and paste in to a flow chart. Students should show chemical reactions wherever possible.

1 The bauxite must be crushed into a fine powder and mixed with sodium hydroxide to form a slurry.

2 High pressure and temperatures are used to encourage the aluminium to react with the sodium hydroxide to form sodium aluminate solution. Many other impurities will not dissolve in the caustic soda.

3 The impurities are allowed to settle and are then filtered out.

4 The still-warm sodium aluminate solution is pumped into large tanks and seed crystals of alumina are added. Alumina crystals form around the seed crystals as the solution cools. The increased weight causes the crystals to sink to the bottom, where they can be filtered off.

5 The resulting precipitate is rinsed and dried, eventually producing a fine white powder.

6 The alumina powder is dissolved in cryolite and an electric current is passed through the mixture. The resulting electrolysis produces metallic aluminium.

Going further:

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

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Teacher notes

4.2 Acid reactions depend on strength and concentration

Pages 92–93

Introducing the topic

Acids react with many different compound and form similar products, always following the same patterns. They can be strong, weak, concentrated or dilute solution.

Teaching tip: prior learning

Students investigated acid reactions in year 9. This content should be revised/pretested before starting.

Teaching tip: strength vs concentration complexity and visualisation

Many students, even at a VCE level, struggle with the concept, as their real world understanding of something concentrated is that it is strong. This misconception must be overcome first.

Get students to draw a strong vs weak solution and a concentrated vs dilute solution. They get students drawing a strong concentrated solution, a weak concentrated solution, a strong dilute solution and a weak dilute solution to visualise these concepts.

Teaching tip: simplified chemical equations

Many of the reactions covered in this chapter can be written in a general form. This may help students to better visualise these reactions in a simplified way.

Acids and metals

acid + metal → salt + H_2

acid + metal oxide → metal salt + H_2O

acid + metal hydroxide → salt + H_2O

acid + metal carbonate → salt + H_2O + CO_2

Additional activity: chemical equation bingo

Students can make up bingo cards with four to six products from the various chemical equations listed above (e.g. CO_2, H_2O, HCl, Mg, O_2, H_2, MgO, $CuSO_4$, NaCl). The reactants of an equation can then be read out. If the student has a product of the equation on their bingo card it can be crossed off ('the product of a combustion reaction'). When students have crossed off all the chemicals on their list, they should shout 'BINGO!'.

Additional activity: acid and metal reactions

Many of these reactions have already been experienced by students. A class can be broken into groups to demonstrate an example of each reaction to the rest of the class.

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Students should write up a method for each experiment, including the list of equipment they need, the concentrations of the chemicals and the safety hazards to be aware of (they may use previous experiments as a guide). Each group should present their experiment, together with a balanced equation and a generalised equation for the reaction.

Possible reactions students could use are detailed below.

Acids and metals

• Adding magnesium ribbon to 1 M HCl will produce hydrogen and magnesium chloride.

• The 'pop test' from earlier in this chapter will demonstrate the production of hydrogen.

Acids and metal oxides

• A rusty nail and a drop of 1 M HCl (in the presence of universal indicator)

Acids and metal hydroxides

• 1 M HCl and 1 M NaOH (in the presence of universal indicator)

Acids and metal carbonates

• making sherbet ($\frac{1}{2}$ teaspoon citric acid, $\frac{1}{4}$ teaspoon bicarbonate soda, icing sugar and jelly crystals)

OR

• vinegar and bicarbonate soda

• students can test for the presence of carbon dioxide using a lit splint.

Additional activity: research acids

Get students to research where common acids are found naturally and share them with the class – for example, stomach acid in HCL.

One example may include:

The most common acid found in the environment is carbonic acid. A very weak acid it is formed when carbon dioxide is dissolved in the water according to the reaction:

$CO_2 + H_2O \rightarrow H_2CO_3$

Although this acid plays an important role in controlling breathing in humans, it can cause a pH of 5.5 by the time rain falls to the ground. This may seem strong enough to do some damage; however, it is the acids formed by sulfur and nitrogen gases in pollution that cause much greater damage to exposed metal surfaces, limestone and plant life.

Going further:

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

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Teacher notes

4.3 The solubility rules predict the formation of precipitates

Pages 94–95

Introducing the topic

Solubility rules will predict if a product in an ionic reaction (double displacement reaction) will form a solid (s) or remain dissolved in solution (aq – aqueous).

Additional activity: predicting the products of precipitation reactions

Before completing the precipitation experiment, ask students to predict whether products will be soluble or insoluble according to the solubility rules, see below.

Lower level students can simply say ‘solid’ or ‘aqueous’, while higher level students can write out the balanced chemical equation, balance it and assign states before conducting the experiment.

This will form their hypothesis for the experiment.

Teaching tip: simplified chemical equations

Many of the reactions covered in this chapter can be written in a general form. This may help students to better visualise these reactions in a simplified way.

Precipitation

soluble + soluble → insoluble + soluble

Additional activity: research

Ask students to research where precipitation reactions are used in society. They must then report back to the class. Some examples include:

- making pigments — some paints such as Prussian blue are created through a chemical reaction between ferric chloride and potassium ferrocyanide that causes an insoluble pigment to be formed; this pigment is then dried and can be used
- testing for the presence of contaminants in water — many commercially produced tests use the principle of adding a compound to water that will react with possible contaminants, causing them to precipitate (giving a positive result for contamination)
- identifying blood types — if the wrong blood type is transfused into a person, their blood will clot. Precipitation reactions are used to identify the blood type of a person before transfusion
- softening hard water — water containing calcium ions and magnesium ions is said to be ‘hard’. This interferes with the use of soap when cleaning. Sodium carbonate can be used to cause the metal ions to precipitate. The solids can then be filtered out, making the water more appropriate for use
- metal purification — many commercial companies use precipitation to separate metals from their naturally occurring ores.

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Solubility rules

Many students have difficulty understanding the rules of solubility. Many students need to be encouraged to approach this in a systematic manner.

Nitrates (NO_3^-)	all soluble
Chlorides (Cl^-)	all soluble **EXCEPT** Ag^+, Hg^{2+}, (Pb^{2+} slightly soluble)
Bromides (Br^-)	all soluble **EXCEPT** Ag^+, Hg^{2+}, Pb^{2+}
Iodides (I^-)	all soluble **EXCEPT** Ag^+, Hg^{2+}, Pb^{2+}
Sulfates (SO_4^{2-})	all soluble **EXCEPT** Ba^{2+}, Pb^{2+} (Ca^{2+} slightly soluble)
Carbonates (CO_3^{2-})	all **In**soluble **EXCEPT** Na^+, K^+, NH_4^+ (Li^+ slightly soluble)
Phosphates (PO_4^{3-})	all **In**soluble **EXCEPT** Na^+, K^+, NH_4^+ (Li^+ slightly soluble)
Hydroxides (OH^-)	all **In**soluble **EXCEPT** Na^+, K^+, NH_4^+, Li^+ (Ba^{2+}, Ca^{2+} slightly soluble)
Sulfides (S^{2-})	all **In**soluble **EXCEPT** Li^+, Na^+, K^+ and the Group 2 Sulfides

Going further:

A useful weblink is available on your obook/assess for Balancing Chemical Equations. To access it, click the weblink tile on the Dashboard for this unit.

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Teacher notes

4.4 Combustion reactions between hydrocarbons and oxygen produce carbon dioxide, water and energy

Pages 96–97

Introducing the topic

Combustion reactions form some of the most important reactions for our society. Not only do they produce large amounts of energy but they also produce carbon dioxide which may be harmful to the environment.

Teaching tip: simplified chemical equations

Many of the reactions covered in this chapter can be written in a general form. This may help students to better visualise these reactions in a simplified way.

Combustion

fuel + O_2 → H_2O + CO_2 + energy

metal + O_2 → metal oxide + energy

Additional activity: combustion discussion

A discussion of burning fuel provides an excellent opportunity to brainstorm the use of combustion reactions in society. Ask students where chemical reactions are used to generate energy and create a conversation around other products that are produced.

This may lead into a conversation on renewable and no-renewable sources of energy. Biofuels, when combusted, do not contribute to greenhouse gases and the CO_2 released from the process is just the CO_2 which has already come from the atmosphere. Fossil fuels, however, have been storing CO_2 for millions of years and so when they are burnt will increase the concentration of CO_2 in the atmosphere.

Additional activity: balanced chemical equations practice

Allow students to practise writing the products of balanced chemical equations and assigning states. If hydrocarbons (specifically alkanes) are used, there is a pattern in the complexity of balancing where the hydrocarbons which have an even number of carbons are trickier to balance.

Get the more advanced students to come up with a hypothesis which explain why.

Going further:

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

BBC Bitesize: Products and Effects of Combustion

http://www.bbc.co.uk/education/guides/z6xbkqt/activity

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Teacher notes

4.5 Polymers are long chains of monomers

Pages 98–99

Introducing the topic

The concept of polymers consisting of a chain of smaller units (called monomers) is an important part of senior chemistry and biology. It explores the structure, bonding and properties of various plastics.

Teaching tip: prior learning

Link this topic to electron configuration and covalent bonding when discussing the structures of polymers and that no metals are found in these structures.

Teaching tip: real world applications/ brainstorming

Start a discussion with students by getting them to look around and identify the polymers that they can see, this can be turned into a list. Students can they start to investigate which are recyclable and non-recyclable, which are cross-linked and linear, which are thermosetting and thermos plastic.

If possible, get them to identify the plastic and look for trends between the type of plastic and the properties identified above.

This can be transformed into a mind map.

Teaching tip: bubble wrap buildings

Introduce students to a building made of bubble wrap and ask them to identify the advantages and disadvantages. Students share these responses with the class.

Advantages/ Disadvantages:

Ethylene tetrafluoroethylene is a 250 micrometre-thick lightweight polymer. Stretching it thin and then folding it creates small air bubbles within the material that lets light pass through whilst trapping and storing heat. This provides insulation much like that of a ‘doona’ that is also fire resistant, shatter-proof and can be easily cleaned. The light weight of the panels means the support framework is also lighter and hence easier to construct than traditional glass panels. The overall effect is much like that of a greenhouse with 90% of the heat being trapped and recycled into heating the pools inside. One of the disadvantages of this material is that it transmits sound at a greater level than glass. This can make it very noisy when it rains as the air pockets in the ethylene tetrafluoroethylene can act as mini drums, magnifying the sound.

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Additional activity: modelling polymers

Paper chains can be used to represent linear polymers that form a long chain. Every tenth link in the chain can be a different colour, representing the nitrogen atom in nylon. Branches can hang off this link.

The cross-linked polymer can be made using a series of rubber bands. The bands can be folded over a paperclip with the two end loops hanging off together. A second rubber band can be passed through the loops of the first band and folded over. The third band passes through the loops of the second and so on. This will create a chain of loops that will be elastic. The ends of the chain can be tied off with a small strip of elastic. This elastic can also be used to link several such chains together, representing the elastic lattice nature of these polymers.

The paper chain can also be called a 'thermosetting polymer', which does not change shape when heated but can char.

The elastic bands can also represent thermoplastic polymers (or elastomers) because they spring back into shape when stretched.

It is often important for students to link the theory to everyday items. Ask students to bring in an item they think is made of nylon and ask them to explain the properties of their item in terms of the properties of nylon. This creates relevance in the study of chemistry and provides an opportunity to discuss possible careers in chemistry.

Going further:

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

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Teacher notes

4.6 Temperature, concentration, surface area and stirring affect reaction rate

Pages 100–103

Introducing the topic

This section explores how energy is used and produced in chemical reactions. It investigates the effect that various effect have on the rate of a chemical reaction. It is important to revise the particle model for students to understand the collision theory.

Teaching tip: real world rates of reaction

A discussion of burning fuel provides an excellent opportunity to introduce rates of reaction. A campfire can be used as an example. The rate at which a fire burns (indicated by how hot it is) can be increased by:

- adding more wood or blowing on the fire (increasing the concentration of reactants)
- chopping the wood into smaller pieces (increasing the surface area of the reactants)
- starting the fire on a hot day (increasing the temperature).

These general principles can be revisited in the next section of this chapter.

Teaching tip: rates of reaction jigsaw activity

This is an ideal topic for a jigsaw activity. A class can be broken into groups, with each group to research one of these methods.

Each student should write down what their group discovers. When finished, one student from each group reports back to a second group to describe their research.

Together, the second group should discuss how the movement of particles can explain the first group's findings.

The rusting of an iron bridge can be prevented by a coat of paint, which provides a barrier against the oxygen needed for the oxidation process. Alternatively, key parts of a bridge (such as bolts) can be galvanised before they are used. This provides a protective coating of zinc over the bolt, preventing damage.

Bread is made with yeast. Yeast undergoes respiration, producing carbon dioxide. If the yeast in 'rising bread' is kept warm, it will respire faster, producing more carbon dioxide for the bread to rise faster.

To speed up the oxidation of alcohol to make vinegar, the mixture can be heated and extra oxygen mixed through.

To increase the combustion of fuel in a rocket engine, extra oxygen can be added.

The activity of a pain-killing drug can be increased by having a stronger concentration of the drug.

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Reactions can be increased by

- increasing the concentration of the reactants (more particles to collide and react)
- increasing the temperature of the reactants (particles move faster and collide more often)
- adding a catalyst (helps the particles to meet)
- decreasing the size of the reactant particles (greater surface area for a reaction to occur)
- stirring the mixture (helps the particles meet).

Teaching tip: real world rates of reaction analogies

In getting students to understand the reasons why industry needs to speed up or slow down a chemical reaction, they can brainstorm and share an everyday examples where they needed to speed up. Some examples include:

- In a hurry to get to school? Crush the multivitamin so that it dissolves faster.
- Really bad headache? Crush the aspirin or Panadol tablet so that it dissolves or is absorbed faster.
- Bath salts will dissolve faster in a hot bath than in a warm bath.
- A fire will light quicker and be hotter if it has easy access to oxygen.
- Closing a door behind you when escaping from a fire will make the fire burn slower.
- Painting over a scratch on a bike will prevent the bike from rusting.
- Chewing food will speed up the rate at which it is digested.
- High-octane fuel has a higher concentration of burnable fuel. Thus, the combustion reactions in an engine will be more effective.

Additional activity: designing your own experiment

Students design an experiment to discover how to make an alka-seltzer tablet dissolve faster. Students are given a demonstration of an alka-selzer tablet dissolving in 100mL of water. The teacher must record the temperature of the water and time how long it takes the tablet to dissolve. Students record this information in the demonstration section below:

Demonstration

Materials:

- 1 alka-seltzer tablet
- 250mL beaker
- 100mL measuring cylinder
- 100mL water

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- Thermometer
- Stop watch

Method:

1. Place 100mL of water in the beaker.
2. Measure the temperature of the water and record this on your handout, below.
3. (Have the stop watch ready) Place the alka-seltzer tablet in the water and time how long it takes to dissolve.
4. Record your results on your handout, below.

Temperature of the water:

Time taken to dissolve:

What did you observe happening?

Student Investigation

What If?

- What if warm water was used?
- What if cold water was used?
- What if the tablet was broken up?
- What if 200mL of water was used?
- What if 50mL of water was used?

You may choose from the following materials:

- Kettle
- Ice
- Mortar and pestle
- Butter knife
- 200mL measuring cylinder
- 1 alka-seltzer tablet
- 250mL beaker
- 100mL measuring cylinder
- 100mL water

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- Thermometer
- Stop watch

They must then design, carry out and write up their experimental report using their knowledge of the rates of chemical reaction in a poster format, as per new VCAA Chemistry assessment guidelines.

Additional activity: kinaesthetic modelling activities

How can you speed up the rate of a chemical reaction?

Temperature

Everything around us is made up of moving particles. In solids, the particles are vibrating; in liquids, they are rolling over each other; and in gases, there is little attraction between them so they bounce around in the available space. This then extends to temperature. Hot particles move faster than slow particles. Get students to walk and then speed walk in straight lines around the room to see how often they meet another student.

Increase the surface area

The concept of surface area can be easily demonstrated using small building blocks (like Lego). The blocks should be a mix of single cubes, double cubes or larger ones. Draw a template of a single square. This can then be duplicated until a grid is formed (like graph paper).

The students can then compare how many squares it takes to cover four single blocks compared with the four blocks jointed together. Students should realise the volume (and hence the mass) is constant; however, the number of squares reflects the surface available for the reaction to occur.

Increasing the concentration and/or temperature

This can be demonstrated by students moving around a set area. Measure and mark a square 3 m × 3 m on the ground. This is the set volume. Place two students (molecules) in the square and ask them to move around randomly. (Every time they bump into each other, a reaction will occur.) Then increase the concentration by placing four students (molecules) in the square. The number of collisions will increase, representing the increase in the rate of the reaction.

An increase in temperature can be represented by the students moving at a faster pace as they move around the square.

Stir and mix – use a catalyst

This activity is dependent on the atmosphere of the class. Teachers should use their judgement to determine whether this activity is appropriate.

Stirring and mixing can be demonstrated using the activity above. The 3 m × 3 m square is measured out on the ground and two or four students are placed in the square and told to move around to represent molecules moving in a set volume. To demonstrate mixing, when the students move to the outer reaches of the square, other students placed around the square can gently push them towards the centre of the square. This should increase the number of collisions between the two (or four) students (molecules), demonstrating an increase in the rate of the reaction.

The effectiveness of a catalyst can be demonstrated by placing a responsible student (or teacher) in the square to pull the moving molecules towards each other. The catalyst should not chase the students;

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however, when a student is within range they should hold on to them until a second student is in range and then cause them to bump gently into each other. The catalyst should then release all molecules and start again. This is to demonstrate that a catalyst must be in contact with the molecules before being activated.

Developing an understanding of the movement of molecules is difficult for many students because they must imagine the movements and reactions of things too small to see. Kinaesthetic activities, such as those described above, can assist in developing the students' understanding of such concepts.

Going further:

Many useful weblinks are available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

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Teacher notes

4.7 Catalysts increase the rate of a reaction

Pages 104–105

Introducing the topic

Catalysts increase the rate of a chemical reaction without being used up. They can therefore be re-used and are essential in chemical industry, as it allows reactions to occur at an optimal speed to produce chemical products such as medicines at a rate which satisfies consumer need.

Teaching tip: terminology

It is important to use the correct terminology when discussing these concepts. It is incorrect to say ‘catalysts do not take part in the reaction’. Catalysts, such as enzymes, must be in contact with the reactants in order to speed up the rate of the reaction. Therefore, they do take part in the reaction. They do not, however, get used up in the reaction.

Differentiation

Higher level students would benefit from looking at chemical rate diagrams for endothermic and exothermic reactions. On these rate diagrams they must draw the effect of a catalyst as lowering the activation energy of a chemical reaction (i.e. the energy required to break reactant bonds) and explain why this happens.

The idea of reversible reactions is an important concept to introduce to students at this level because it leads into equilibrium, which is often a part of senior chemistry studies. Reversible reactions occur in closed systems where the amount of reactants is limited and the products are not removed.

Many reactions start with a large number of reactants and little product. As the reactions progress, the amount of reactants decreases and the number of products increases. Some products undergo spontaneous breakdown so that the reactants reform. This is reversal. As the reaction continues, the amount of product being formed will eventually be equal to the amount being reversed. This is the concept of chemical equilibrium. A simple analogy is walking the wrong way on an escalator. You walk forwards at the same speed as the escalator is moving backwards. Both you and the escalator are moving, but you are not going anywhere.

Additional activity: experiment 4.7 extension

As a fun additional aspect of Experiment 4.7, if you add a small squirt of dishwashing detergent and two drops of food dye before adding the manganese dioxide powder, the bubbles that are generated during the experiment will be captured in a colourful stream of bubbles.

This experiment is referred to as the ‘Foam Column’ or ‘Elephant’s Toothpaste’.

There are many youtube videos which demonstrate this concept.

There is a disadvantage in a school, in that the hydrogen peroxide used is of a lower concentration. The higher the concentration, the more bubbles produced and the better the effect. The videos use high concentration chemical.

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Additional activity: iodine clock experiment

This is another great experiment to show to students, perhaps in a youtube video, as it can be lengthy to set-up.

It demonstrates higher concentrations reacting faster and lower concentrations taking longer to react.

Going further:

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

Iodine Clock: https://www.youtube.com/watch?v=_qhYDuJt8fI

Elephant's Toothpaste: https://www.youtube.com/watch?v=p1eG2y2mn54

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Teacher notes

4.8 Green chemistry reduces the impact of chemicals on the environment

Pages 106–107

Introducing the topic

Chemists use green chemical principals to reduce the amount of pollutants and waste generated in chemical reactions. They also do this to reduce the amount of hazardous waste and create a safer and cleaner world.

Additional activity: brainstorm

Get students to brainstorm the everyday items that they use which are produced in chemical reactions or harm the environment.

For every item that they brainstorm, another student must propose a method of reducing this waste or improving this process.

Additional activity: research

The use of chemicals previously thought to be safe is constantly being revised by government scientists. Students can research some of these chemicals, including those listed below, to discover their original uses and the reasons behind the review of their use.

- thalidomide
- asbestos
- benzene
- chlorobenzidine
- DDT

Additional activity: informational poster

Students must generate a poster of one ‘non-green’ chemical product and create an informational poster outlining the hazards involved, where the products end up (i.e. waste) and how everyone can adjust/improve their daily practices in order to use more ‘green’ chemicals or reduce the waste.

Going further:

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

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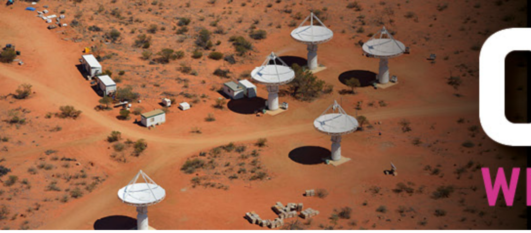

Suggested teaching program

Chapter 4: Chemical reactions

Time allocation: 5–6 weeks

Context and overview
In year 10, students investigate the different types of chemical reactions which are used to produce a range of products and which occur at different rates.
Syllabus outcomes addressed
• Different types of chemical reactions are used to produce a range of products and can occur at different rates (ACSSU187) • Scientific understanding, including models and theories, is contestable and are refined over time through a process of review by the scientific community ACSHE157 • Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries ACSHE158 • People can use scientific knowledge to evaluate whether they should accept claims, explanations or predictions, and advances in science can affect people’s lives, including generating new career opportunities ACSHE160 • The values and needs of contemporary society can influence the focus of scientific research ACSHE228 • Formulate questions or hypotheses that can be investigated scientifically ACSIS164 • Plan, select and use appropriate investigation methods, including field work and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods ACSIS165 • Select and use appropriate equipment, including digital technologies, to systematically and accurately collect and record data ACSIS166 • Analyse patterns and trends in data, including describing relationships between variables and identifying inconsistencies ACSIS169 • Use knowledge of scientific concepts to draw conclusions that are consistent with evidence ACSIS170 • Evaluate conclusions, including identifying sources of uncertainty and possible alternative explanations, and describe specific ways to improve the quality of the data ACSIS171 • Critically analyse the validity of information in secondary sources and evaluate the approaches used to solve problems ACSIS172 • Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations ACSIS174

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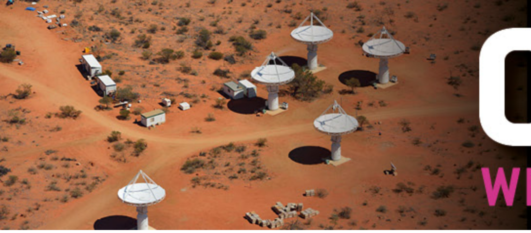

Achievement standards
Students explain how chemical reactions are used to produce particular products and how different factors influence the rate of reactions. They investigate how chemistry can be used to produce a range of useful substances such as fuels, metals and pharmaceuticals. Students predict the products of different types of simple chemical reactions using word or symbol equations and they investigate the effect of a range of factors, such as temperature and catalysts, on the rate of chemical reactions. Students design questions that can be investigated using a range of inquiry skills. They design methods that include the control and accurate measurement of variables and systematic collection of data and describe how they considered ethics and safety. They analyse trends in data, identify relationships between variables and reveal inconsistencies in results. They analyse their methods and the quality of their data, and explain specific actions to improve the quality of their evidence. They evaluate others' methods and explanations from a scientific perspective and use appropriate language and representations when communicating their findings and ideas to specific audiences.

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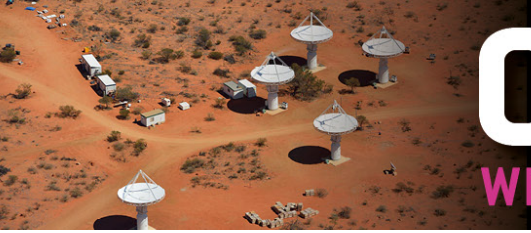

Student book section	AC Syllabus links	Suggested indicators of learning and understanding	Suggested teaching and learning activities	Resources
4.1 Synthesis and decomposition reactions can be represented by equations (pages 89–91)	Science Understanding ACSSU187 Science as a Human Endeavour ACSHE191 ACSHE158 ACSHE160 ACSHE228 Science Inquiry Skills ACSIS198 ACSIS199 ACSIS200 ACSIS203 ACSIS204 ACSIS205 ACSIS208	By the end of this unit, students should be able to: • recognise the difference between a synthesis and decomposition reaction • explain that heat and electricity and sometimes needed in decomposition reactions • write, balance and assign states to simple synthesis and decomposition reaction equations.	**What if?** Students investigate the application of a battery (electric current) to a chemical reaction and determine the effect that different voltages will have on the outcome of the experiment. These experiments are excellent demos if time within the classroom is limited. **Experiment 4.1A** Direct Synthesis with a POP. Students produce water using a direct synthesis reaction. They then relate this knowledge to synthesis and decomposition reactions and can use the results to identify this as: Acid + Metal → Salt + Hydrogen Gas OR A single displacement reaction NB: technically this is both synthesis and decomposition as the acid decomposes to synthesise the salt and gas. **Experiment 4.1B** Decomposing a Carbonate: Students use heat to decompose	**Oxford Science 10 resources** • What if? Page 89 • Check your learning, page 91 • Experiment 4.1A, page 200 • Experiment 4.1B, page 201 • Experiment 4.1C, page 202 **Additional resources** Phet balancing chemical equations simulation provides a visual animation and simulation to demonstrate the law of conservation of mass. https://phet.colorado.edu/en/simulation/balancing-chemical-equations

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			copper(II) carbonate and produce copper oxide and carbon dioxide. They can build upon this experiment further to design a test which will determine that carbon dioxide was produced (use a lit match, as carbon dioxide extinguishes fire). **Experiment 4.1C** Electrolysis: Students use electricity to produce copper metal from copper(II) sulfate and determine that they have conducted a decomposition reaction. This can be seen as the copper will form on one electrode. A good extension is to ask students whether copper has formed on the positive or negative electrode and explain why. Copper will form on the negative electrode as copper ions are positive.	

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4.2 Acid reactions depend on strength and concentration (pages 92–93)	Science Understanding ACSSU187 Science Inquiry Skills ACSIS198 ACSIS199 ACSIS200 ACSIS203 ACSIS204 ACSIS205 ACSIS208	By the end of this unit, students should be able to: • determine the difference between an acid and a base including key features and properties • identify a neutralisation reactions and explain why it is named this way • write, balance and assign states to neutralisation reactions • identify acid reactions and their products • write, balance and assign states to reactions of acids with: –metal oxides –metal carbonates • explain the difference between acid strength and concentration.	**Experiment 4.2** Acid Titrations: Students compare the reactions of a strong acid (hydrochloric acid), and a weak acid (ethanoic acid – common name acetic acid) by titrating them against a strong base. This experiment demonstrates the difference between strength and concentration. Students should come to the conclusion that an equal volume is required to neutralise the same concentration of acid, regardless of the strength of the acid. Note: this will help students to answer question 5 on page 93.	**Oxford Science 10 resources** • Check your learning, page 93 • Experiment 4.2, page 203 **Additional resources** Phet Acid Base simulation provides a visual animation and simulation to allow students to visualise strong vs weak acids and bases: https://phet.colorado.edu/en/simulation/acid-base-solutions And concentration: https://phet.colorado.edu/en/simulation/concentration
4.3 The solubility rules predict the formation of precipitates (pages 94–95)	Science Understanding ACSSU187 Science Inquiry Skills ACSIS198 ACSIS199 ACSIS200 ACSIS203 ACSIS204	By the end of this unit, students should be able to: • identify precipitation reactions and explain why it is named this way • define the state 'aqueous' as a chemical which is dissolved in water • write, balance and assign states to precipitation reactions • determine whether a chemical is solid (s) or aqueous (aq) based on solubility rules	**Experiment 4.3** Precipitation reactions: Students determine which compounds form precipitates and write equations for the reactions occurring. As a pre-lab activity, get students to write the balanced chemical equations of each reaction and determine whether reactants and products are soluble (aq) or insoluble (s). This will form a hypothesis for each reaction. It	**Oxford Science 10 resources** • Check your learning, page 95 • Experiment 4.3, page 204

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	ACSIS205 ACSIS208	• explain the importance of precipitation reactions.	also gives them practice in developing chemical formulae, balancing and assigning states using the solubility table. An alternative to placing this in a plastic pocket sleeve is to get your lab tech to laminate the table which can be used in future years.	
4.4 Combustion reactions between hydrocarbons and oxygen produce carbon dioxide, water and energy (pages 96–97)	Science Understanding ACSSU187 Science Inquiry Skills ACSIS198 ACSIS199 ACSIS200 ACSIS203 ACSIS204 ACSIS205 ACSIS208	By the end of this unit, students should be able to: • define the terms oxidation, combustion and hydrocarbon • write, balance and assign states to oxidation reactions with: –metals –non-metals • write, balance and assign states to combustion reactions with hydrocarbons • explain the effect of limiting the amount of oxygen in hydrocarbon combustion reactions • identify common chemical fuels and their relation to hydrocarbons • explain “carbon economy” making reference to real world science.	**Experiment 4.4** Combustion of wire wool: Students observe the oxidation of wire wool. Students determine the balanced chemical equation, including states, for the reaction, then apply this to the law of conservation of mass and exothermic/endothermic reactions.	**Oxford Science 10 resources** • Check your learning, page 97 • Experiment 4.4, page 205

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4.5 Polymers are long chains of monomers (pages 98–99)	Science Understanding ACSSU187 Science Inquiry Skills ACSIS198 ACSIS199 ACSIS200 ACSIS203 ACSIS204 ACSIS205 ACSIS208	By the end of this unit, students should be able to: • define the terms monomer, polymer, cross-linked, thermosetting and thermoplastic • explain the properties of polymers based on their structures • determine whether polymers are thermoplastic or thermosetting based on their properties and determine where this knowledge may be useful around the home/ real world • explain the formation of polymers and relate the name of a polymer to the name of its monomer units.	**Experiment 4.5** Polymerisation of casein: Students use milk and ethanoic acid to form casein plastic: polymers of casein monomers. Casein is a protein found in mammalian milk products. A version of this experiment is located within the Year 8 student book to create casein glue. This is an excellent activity for any teacher who would like to incorporate STEM into the classroom as it incorporates chemical engineering. Thermoplastic polymer can also be purchased at science supply stores to demonstrate to students, or get them to play with. This is excellent at demonstrating the mold-ability of the plastic when it is warm and only needs to be placed in hot water. When cold, the plastic becomes hard.	**Oxford Science 10 resources** • Check your learning, page 99 • Experiment 4.5, page 206 **Additional resources** Crash Course Chemistry: Polymers – a good, if somewhat fast, summary of common polymers and their monomers. It can get a little advanced, but the first 5–6 minutes is great. https://www.youtube.com/watch?v=rHxxLYzJ8Sw
4.6 Temperature, concentration, surface area and stirring affect reaction rate (pages 100–103)	Science Understanding ACSSU187 Science Inquiry Skills ACSIS198 ACSIS199	By the end of this unit, students should be able to: • define collision theory and identify how this relates to the rate of a chemical reaction • identify the key elements required for molecules to collide and result in a successful reaction which forms products	**Experiment 4.6A** The effect of temperature on reaction rate: Students investigate the effect of temperature on reaction rate. **Experiment 4.6B** Factors affecting reaction rate: Students investigate the rates of a	**Oxford Science 10 resources** • Check your learning, page 103 • Experiment 4.6A, page 207 • Experiment 4.6B, page 208 **Additional resources** YouTube Video “How to speed up chemical reactions (and get a date) – Aaron Sams”

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	ACSIS200 ACSIS203 ACSIS204 ACSIS205 ACSIS208	• explain how to increase the rate of a chemical reaction using collision theory for: –surface area –concentration –temperature –stirring.	reaction between hydrochloric acid and calcium carbonate. This experiment determines the effect of surface area on the rate of a chemical reaction. The inquiry aspect of Experiment 4.6B is an excellent way of assessing science inquiry skills. Set students the challenge of writing this as a scientific poster in preparation for VCE Sciences.	https://www.youtube.com/watch?v=OttRV5ykP7A Phet Reactions and Rates simulation provides a visual animation and simulation to allow students to visualise collision theory as well as the effect of temperature and concentration https://phet.colorado.edu/en/simulation/legacy/reactions-and-rates
4.7 Catalysts increase the rate of a reaction (pages 104–105)	Science Understanding ACSSU187 Science Inquiry Skills ACSIS198 ACSIS199 ACSIS200 ACSIS203 ACSIS204 ACSIS205 ACSIS208	By the end of this unit, students should be able to: • define what a catalyst is and how it can increase the rate of a chemical reaction • explain the two types of catalysts and give examples • explain real world examples of reactions which require catalysts and determine whether they are beneficial to society.	**Experiment 4.7** Using a catalyst: Students investigate the effect of adding a catalyst to a reaction. The reaction used in this experiment is the decomposition of hydrogen peroxide: $2\ H_2O_2\,(aq) \rightarrow 2\ H_2O\ (l) + O_2\,(g)$ This experiment can be performed on a grander scale using the foam column/'elephant's toothpaste' experiment. If you are unable to perform this in class, there are many YouTube videos which demonstrate this.	**Oxford Science 10 resources** • Check your learning, page 105 • Experiment 4.7, page 209 **Additional resources** YouTube Video Elephant's Toothpaste Geyser With Science Bob on Jimmy Kimmel https://www.youtube.com/watch?v=p1eG2y2mn54 There are many more videos similar to this one online.

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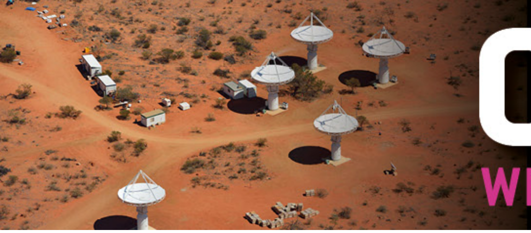

4.8 Green chemistry reduces the impact of chemicals on the environment (pages 106–107)	Science Understanding ACSSU186 Science as a Human Endeavour ACSHE192 ACSHE194 ACSHE230 Science Inquiry Skills ACSIS204 ACSIS205 ACSIS208	By the end of this unit, students should be able to: • define what green chemistry is and why it is beneficial to the environment/ society • explain the negative cost of: –low-impact chemicals –pesticides and herbicides –heavy metals –solvent-based paints and why they are no longer used • determine how people (particularly themselves), as citizens, can utilise the principals of green chemistry to reduce their carbon footprint.	**Activity:** Green chemistry provides teachers with a great opportunity to get students reading scientific journals and articles. Not only will this improve reading skills but it will expand their vocabulary. Get students to find articles, summarise them and present to the class on the Principals of Green Chemistry and its application within their lives.	**Oxford Science 10 resources** • Extend your understanding, page 107
4 Review (pages 108–109)	Science Understanding ACSSU186 Science as a Human Endeavour ACSHE191 ACSHE192 ACSHE194 ACSHE230	By the end of this unit, students should be able to: • define all Key words listed on page 110 • identify, write, balance and assign states to chemical reactions: –synthesis –decomposition –acid –precipitation –combustion –polymers • explain chemical rates of reaction	**Revision activities** • Students could play celebrity heads with the Key words list • Students can make dominoes with Key words on one end and definitions/diagrams/examples on the other end • Students can create mind maps, Venn diagrams or other graphic organisers to summarise the key concepts of this chapter • Peer teaching: students can work in groups to reteach the content of the unit to the class for the purpose of	**Oxford Science 10 resources** • Review questions, pages 108–109 • Research topics, page 109 • Key words list, page 110

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	Science Inquiry Skills ACSIS208	and the factors which affect them • explain how catalysts can affect a chemical rate of reaction • define green chemistry and explain how this benefits society • identify areas of personal strengths and weaknesses in their knowledge and understanding of the topic.	revision. Each group could be allocated a double-page to summarise.	

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