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# VICTORIAN CURRICULUM LEVELS 7–10



## LEVELS 7 & 8

### LEVEL BAND DESCRIPTION

In Levels 7 and 8, the curriculum focus is on explaining phenomena involving science and its applications. Students explain the role of classification in ordering and organising information about living and non-living things. They classify the diversity of life on Earth into major taxonomic groups and consider how the classification of renewable and non-renewable resources depends on the timescale considered. Students classify different forms of energy, and describe the role of energy in causing change in systems, including the role of heat and kinetic energy in the rock cycle. They use and develop models including food chains, food webs and the water cycle to represent and analyse the flow of energy and matter through ecosystems and explore the impact of changing components within these systems. Students investigate relationships in the Earth-Sun-Moon system and use models to predict and explain astronomical phenomena. They explain changes in an object's motion by considering the interaction between multiple forces. Students link form and function at a cellular level and explore the organisation and interconnectedness of body systems. Similarly, they explore changes in matter at a particle level, and distinguish between chemical and physical change. Students make accurate measurements and control variables in experiments to analyse relationships between system components and explore and explain these relationships using appropriate representations. They make predictions and propose explanations, drawing on evidence to support their views.

### KEY CONCEPTS

**PATTERNS, ORDER & ORGANISATION**

An important aspect of science is recognising patterns in the world around us, and ordering and organising phenomena at different scales. Students observe and describe patterns at different scales, and develop and use classifications to organise events and phenomena and make predictions. Classifying objects and events into groups (such as solid/liquid/gas or living/non-living) and developing criteria for those groupings relies on making observations and identifying patterns of similarity and difference. Students identify and describe the relationships that underpin patterns, including cause and effect. Students recognise that scale plays an important role in the observation of patterns and that some patterns may only be evident at certain time and spatial scales. For example, the pattern of day and night is not evident over the time scale of an hour.

**FORM AND FUNCTION**

Many aspects of science are concerned with the relationships between form (the nature or make-up of an aspect of an object or organism) and function (the use of that aspect). Students learn that the functions of both living and non-living objects rely on their forms. Their understanding of forms, such as the features of living things or the nature of a range of materials, and their related functions or uses, is based on observable behaviours and physical properties. Students recognise that function frequently relies on form and that this relationship can be examined at many scales. They apply an understanding of microscopic and atomic structures, interactions of force and flows of energy and matter to describe relationships between form and function.

**STABILITY & CHANGE**

Many areas of science involve the recognition, description and prediction of stability and change. Students recognise from their observations of the world around them that some properties and phenomena appear to remain stable or constant over time, whereas others change. They also learn to recognise that phenomena (such as properties of objects and relationships between living things) can appear to be stable at one spatial or time scale, but at a larger or smaller scale may be seen to be changing. They appreciate that stability can be the result of competing but balanced forces. Students become adept at quantifying change through measurement and looking for patterns of change by representing and analysing data in tables or graphs.

**SCALE & MEASUREMENT**

Quantification of time and spatial scale is critical to the development of science understanding as it enables the comparison of observations. Students are challenged to work with scales that are outside their everyday experience, including distances in space, the size of atoms and the slow geological processes that occur over time. As students gain an understanding of relative sizes and rates of change, they are able to conceptualise events and phenomena at a wider range of scales.

**MATTER & ENERGY**

Many aspects of science involve identifying, describing and measuring transfers of energy and/or matter. Students become increasingly able to explain phenomena in terms of the flow of matter and energy. Initially, students focus on direct experience and observation of phenomena and materials. They are introduced to the ways in which objects and living things change and begin to recognise the role of energy and matter in these changes. In later levels, they are introduced to more abstract notions of particles, forces and energy transfer and transformation. They use these understandings to describe and model phenomena and processes involving matter and energy.

**SYSTEMS**

Science involves systems thinking, modelling and analysis in order to understand, explain and predict events and phenomena. Students explore, describe and analyse increasingly complex systems. Initially, students identify the observable components of a clearly identified 'whole' such as features of plants and animals and parts of mixtures. They identify and describe relationships between components within simple systems, and they begin to appreciate that components within living and non-living systems are interdependent. They are introduced to the processes and underlying phenomena that structure systems such as ecosystems, body systems and the carbon cycle. They recognise that within systems, interactions between components can involve forces and changes acting in opposing directions and that for a system to be in a steady state, these factors need to be in a state of balance or equilibrium. They are increasingly aware that systems can exist as components within larger systems, and that one important part of thinking about systems is identifying boundaries, inputs and outputs.

### SCIENCE UNDERSTANDING

| SCIENCE AS A HUMAN ENDEAVOUR | BIOLOGICAL SCIENCES | CHEMICAL SCIENCES | EARTH & SPACE SCIENCES | PHYSICAL SCIENCES |
|---|---|---|---|---|
| • Scientific knowledge and understanding of the world changes as new evidence becomes available; science knowledge can develop through collaboration and connecting ideas across the disciplines and practice of science across the disciplines **(VCSSU089)**<br>• 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 **(VCSSU090)** | • There are differences within and between groups of organisms; classification helps organise this diversity **(VCSSU091)**<br>• Cells are the basic units of living things and have specialised structures and functions **(VCSSU092)**<br>• Interactions between organisms can be described in terms of food chains and food webs and can be affected by human activity **(VCSSU093)**<br>• Multicellular organisms contain systems of organs that carry out specialised functions that enable them to survive and reproduce **(VCSSU094)** | • Mixtures, including solutions, contain a combination of pure substances that can be separated using a range of techniques **(VCSSU095)**<br>• The properties of the different states of matter can be explained in terms of the motion and arrangement of particles **(VCSSU096)**<br>• Differences between elements, compounds and mixtures can be described by using a particle model **(VCSSU097)**<br>• Chemical change involves substances reacting to form new substances **(VCSSU098)** | • Predictable phenomena on Earth, including seasons and eclipses, are caused by the relative positions of the Sun, Earth and the Moon **(VCSSU099)**<br>• Some of Earth's resources are renewable, but others are non-renewable **(VCSSU100)**<br>• Water is an important resource that cycles through the environment **(VCSSU101)**<br>• Sedimentary, igneous and metamorphic rocks contain minerals and are formed by processes that occur within Earth over a variety of timescales **(VCSSU102)** | • Change to an object's motion is caused by unbalanced forces acting on the object; Earth's gravity pulls objects towards the centre of Earth **(VCSSU103)**<br>• Energy appears in different forms including movement (kinetic energy), heat, light, chemical energy and potential energy; devices can change energy from one form to another **(VCSSU104)**<br>• Light can form images using the reflective feature of curved mirrors and the refractive feature of lenses, and can disperse to produce a spectrum which is part of a larger spectrum of radiation **(VCSSU105)**<br>• The properties of sound can be explained by a wave model **(VCSSU106)** |

### SCIENCE INQUIRY SKILLS

**QUESTIONING & PREDICTING**

- Identify questions, problems and claims that can be investigated scientifically and make predictions based on scientific knowledge **(VCSIS107)**

**PLANNING & CONDUCTING**

- Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed **(VCSIS108)**
- In fair tests, measure and control variables, and select equipment to collect data with accuracy appropriate to the task **(VCSIS109)**

**RECORDING & PROCESSING**

- Construct and use a range of representations including graphs, keys and models to record and summarise data from students' own investigations and secondary sources, and to represent and analyse patterns and relationships **(VCSIS110)**

**ANALYSING & EVALUATING**

- Use scientific knowledge and findings from investigations to identify relationships, evaluate claims and draw conclusions **(VCSIS111)**
- 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 **(VCSIS112)**

**COMMUNICATING**

- Communicate ideas, findings and solutions to problems including identifying impacts and limitations of conclusions and using appropriate scientific language and representations **(VCSIS113)**

### ACHIEVEMENT STANDARD

By the end of Level 8, students explain how evidence has led to an improved understanding of a scientific idea. They discuss how science knowledge can be applied to generate solutions to contemporary problems and explain how these solutions may impact on society. They investigate different forms of energy and explain how energy transfers and transformations cause change in simple systems. They use examples to illustrate how light forms images. They use a wave model to explain the properties of sound. They use the particle model to predict, compare and explain the physical and chemical properties and behaviours of substances. They describe and apply techniques to separate pure substances from mixtures. They provide evidence for observed chemical changes in terms of colour change, heat change, gas production and precipitate formation. They analyse the relationship between structure and function at cell, organ and body system levels. They identify and classify living things. They explain how living organisms can be classified into major taxonomic groups based on observable similarities and differences. They predict the effect of environmental changes on feeding relationships between organisms in a food web. They distinguish between different types of simple machines and predict, represent and analyse the effects of unbalanced forces, including Earth's gravity, on motion. They compare processes of rock formation, including the time scales involved, and analyse how the sustainable use of resources depends on the way they are formed and cycle through Earth systems. They model how the relative positions of Earth, the Sun and the Moon affect phenomena on Earth.

Students identify and construct questions and problems that they can investigate scientifically and make predictions based on scientific knowledge. They plan experiments, identifying variables to be changed, measured and controlled. They consider accuracy and ethics when planning investigations, including designing field or experimental methods. Students summarise data from different sources and construct representations of their data to reveal and analyse patterns and relationships, and use these when justifying their conclusions. They explain how modifications to methods could improve the quality of their data and apply their scientific knowledge and investigation findings to evaluate claims made by others. They use appropriate scientific language, representations and simple word equations to communicate science ideas, methods and findings.

## LEVELS 9 & 10

### LEVEL BAND DESCRIPTION

In Levels 9 and 10, the curriculum focus is on explaining phenomena involving science and its applications. Students consider both classic and contemporary science contexts to explain the operation of systems at a range of scales. At a microscopic scale, they consider the atom as a system of protons, electrons and neutrons, and understand how this system can change through nuclear decay. They learn that matter can be rearranged through chemical change and that these changes play an important role in many systems. At a macroscopic scale, they explore ways in which the human body as a system responds to its external environment, and investigate the interdependencies between biotic and abiotic components of ecosystems. They develop a more sophisticated view of energy transfer by applying the concept of the conservation of matter in a variety of contexts. They apply their understanding of energy and forces to global systems including continental movement. Students explore the biological, chemical, geological and physical evidence for different theories, including the theories of natural selection and the Big Bang theory. Atomic theory is used to understand relationships within the periodic table of elements. Students understand that motion and forces are related by applying physical laws. Relationships between aspects of the living, physical and chemical world are applied to systems on a local and global scale enabling students to predict how changes will affect equilibrium within these systems.

### KEY CONCEPTS

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### SCIENCE UNDERSTANDING

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|---|---|---|---|---|
| • Scientific understanding, including models and theories, are contestable and are refined over time through a process of review by the scientific community **(VCSSU114)**<br>• Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries **(VCSSU115)**<br>• The values and needs of contemporary society can influence the focus of scientific research **(VCSSU116)** | Multicellular organisms rely on coordinated and interdependent internal systems to respond to changes to their environment **(VCSSU117)**<br>• An animal's response to a stimulus is coordinated by its central nervous system (brain and spinal cord); neurons transmit electrical impulses and are connected by synapses **(VCSSU118)**<br>• The transmission of heritable characteristics from one generation to the next involves DNA and genes **(VCSSU119)**<br>• The theory of evolution by natural selection explains the diversity of living things and is supported by a range of scientific evidence **(VCSSU120)**<br>• Ecosystems consist of communities of interdependent organisms and abiotic components of the environment; matter and energy flow through these systems **(VCSSU121)** | • All matter is made of atoms which are composed of protons, neutrons and electrons; natural radioactivity arises from the decay of nuclei in atoms **(VCSSU122)**<br>• The atomic structure and properties of elements are used to organise them in the periodic table **(VCSSU123)**<br>• Chemical reactions involve rearranging atoms to form new substances; during a chemical reaction mass is not created or destroyed **(VCSSU124)**<br>• Different types of chemical reactions are used to produce a range of products and can occur at different rates; chemical reactions may be represented by balanced chemical equations **(VCSSU125)**<br>• Chemical reactions, including combustion and the reactions of acids, are important in both non-living and living systems and involve energy transfer **(VCSSU126)** | • The theory of plate tectonics explains global patterns of geological activity and continental movement **(VCSSU127)**<br>• Global systems, including the carbon cycle, rely on interactions involving the atmosphere, biosphere, hydrosphere and lithosphere **(VCSSU128)**<br>• The Universe contains features including galaxies, stars and solar systems; the Big Bang theory can be used to explain the origin of the Universe **(VCSSU129)** | • Electric circuits can be designed for diverse purposes using different components; the operation of circuits can be explained by the concepts of voltage and current **(VCSSU130)**<br>• The interaction of magnets can be explained by a field model; magnets are used in the generation of electricity and the operation of motors **(VCSSU131)**<br>• Energy flow in Earth's atmosphere can be explained by the processes of heat transfer **(VCSSU132)**<br>• The explanation of the motion of objects involves the interaction of forces and the exchange of energy and can be described and predicted using the laws of physics **(VCSSU133)** |

### SCIENCE INQUIRY SKILLS

**QUESTIONING & PREDICTING**

- Formulate questions or hypotheses that can be investigated scientifically, including identification of independent, dependent and controlled variables **(VCSIS134)**

**PLANNING & CONDUCTING**

- Independently plan, select and use appropriate investigation types, including fieldwork and laboratory experimentation, to collect reliable data, assess risk and address ethical issues associated with these investigation types **(VCSIS135)**
- Select and use appropriate equipment and technologies to systematically collect and record accurate and reliable data, and use repeat trials to improve accuracy, precision and reliability **(VCSIS136)**

**RECORDING & PROCESSING**

- Construct and use a range of representations, including graphs, keys, models and formulas, to record and summarise data from students' own investigations and secondary sources, to represent qualitative and quantitative patterns or relationships, and distinguish between discrete and continuous data **(VCSIS137)**

**ANALYSING & EVALUATING**

- Analyse patterns and trends in data, including describing relationships between variables, identifying inconsistencies in data and sources of uncertainty, and drawing conclusions that are consistent with evidence **(VCSIS138)**
- Use knowledge of scientific concepts to evaluate investigation conclusions, including assessing the approaches used to solve problems, critically analysing the validity of information obtained from primary and secondary sources, suggesting possible alternative explanations and describing specific ways to improve the quality of data **(VCSIS139)**

**COMMUNICATING**

- Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations **(VCSIS140)**

### ACHIEVEMENT STANDARD

By the end of Level 10, students analyse how models and theories have developed over time and discuss the factors that prompted their review. They predict how future applications of science and technology may affect people's lives. They explain the concept of energy conservation and model energy transfer and transformation within systems. They analyse how biological systems function and respond to external changes with reference to the interdependencies between individual components, energy transfers and flows of matter. They evaluate the evidence for scientific theories that explain the origin of the Universe and the diversity of life on Earth. They explain the role of DNA and genes in cell division and genetic inheritance. They apply geological timescales to elaborate their explanations of both natural selection and evolution. They explain how similarities in the chemical behaviour of elements and their compounds and their atomic structures are represented in the way the periodic table has been constructed. They compare the properties of a range of elements representative of the major groups and periods in the periodic table. They use atomic symbols and balanced chemical equations to summarise chemical reactions, including neutralisation and combustion. They explain natural radioactivity in terms of atoms and energy change. They explain how different factors influence the rate of reactions. They explain global features and events in terms of geological processes and timescales, and describe and analyse interactions and cycles within and between Earth's spheres. They give both qualitative and quantitative explanations of the relationships between distance, speed, acceleration, mass and force to predict and explain motion. They use the concepts of voltage and current to explain the operation of electric circuits and use a field model to explain interactions between magnets.

Students develop questions and hypotheses that can be investigated using a range of inquiry skills. They independently design and improve appropriate methods of investigation including the control and accurate measurement of variables and systematic collection of data. They explain how they have considered reliability, precision, safety, fairness and ethics in their methods and identify where digital technologies can be used to enhance the quality of data. They analyse trends in data, explain relationships between variables and identify sources of uncertainty. When selecting evidence and developing and justifying conclusions, they account for inconsistencies in results and identify alternative explanations for findings. Students evaluate the validity and reliability of claims made in secondary sources with reference to currently held scientific views, the quality of the methodology and the evidence cited. They construct evidence-based arguments and use appropriate scientific language, representations and balanced chemical equations when communicating their findings and ideas for specific purposes.

Chapter 4: Water

# 4.1 Water cycles through the environment

## Teacher notes (pages 66–67)

### Introducing the topic

Most students have a fair understanding of the water cycle, and it is useful to relate the processes to everyday observations such as condensation on a cold glass or steam from a kettle. Transpiration can be shown with a potometer if available. If not, placing celery in a solution of eosin dye allows students to observe the movement of water up the stem. This process is very quick and can be sped up further by aiming a blow drier or fan at the celery leaves.

### Differentiation

For less able students:

Students will benefit from seeing examples of processes in the water cycle. These may be set up as stations around the class or as teacher demonstrations.

For more able students:

Students can carry out a simple distillation to purify salt water. Test for salts in the distillate by using silver nitrate (which goes cloudy with chlorides).

### Additional activity: Drawing the water cycle from memory

Ask students to draw a labelled diagram of the water cycle without using their books. This task is best performed in small groups so that students remind each other of prior knowledge. As a class, brainstorm the processes involved in the water cycle and make a list on the board. Higher ability students should be able to name most processes. Lower ability students may benefit from having a landscape diagram provided, with or without arrows for processes.

### Additional activity: Different clouds

Ask students to investigate the different types of clouds – how do they form? Why do they look so different?

### Additional activity: Rainfall

Ask students to use the Bureau of Meteorology's website to consider rainfall patterns over the last week. Why do some locations receive more or less rainfall? What factors can affect this?



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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.

**Natural water cycle game**

This website contains the droplet game where you navigate through the water cycle.



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# 4.2 Factors in nature affect the water cycle

## Teacher notes (pages 68–69)

### Introducing the topic

Although water has been cycling since the Earth was first formed, this cycle can be affected by many things. Changes in temperature, the direction of the wind and the number of plants all affect how fast water evaporates, and therefore the amount of water vapour in the air. This section explores El Niño and La Niña events, and how volcano eruptions can affect the water cycle.

### Differentiation

For less able students:

Students with low literacy or English as a second language may struggle with the text and terminology in this section. A cloze task may be a good reading comprehension task for these students.

For more able students:

Students could research La Niña events more extensively and present the information to their classmates. They could incorporate a map of where La Niña events have occurred in the last decade. What affect have these events had?

### Additional activity: El Niño and La Niña

Students can investigate the effects of El Niño and La Niña events on South America. Does South America also experience drought during El Niño and flooding during La Niña?

### Additional activity: Other factors affecting the water cycle

Aside from El Niño and La Niña events, what other things can affect the water cycle? In groups, students could find case studies of other factors that may affect the water cycle and present them to the class.

### Assessment

Students can investigate the effect of major volcanic eruptions on weather patterns. What countries have been affected? Can anything be done? (Tip: research cloud seeding.) This can be presented as a research report with a bibliography to show further research.



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# 4.3 Human management affects the water cycle

## Teacher notes (pages 70–71)

### Introducing the topic

This section looks at the use of water as a resource. Only 3 per cent of water is drinkable, the rest is salt water. Of that 3 per cent, not all of it can be used, most is stored in ice caps and glaciers. Despite what we know about how little water is available for use, Australia is one of the highest users of water per capita (per person) in the world and yet is also the driest populated continent on Earth.

### Differentiation

For less able students:

Students can research the use of water in agriculture. Which agricultural sector requires the most water? Which requires the least?

For more able students:

Students use the graph on page 70 to split up into smaller groups and consider each of the purposes that water is used for. Students make three recommendations on how to save water per purpose. This will require further research online.

### Additional activity: Hydroelectric power

Students can complete a case study of the Snowy Mountains Hydro-Electric Scheme. What was the impact on areas near the dam? What was the impact on the Snowy River? How could this impact be minimised in future? Where else in Australia is hydroelectricity used?

### Additional activity: Desalination

The desalination process can be replicated in a science classroom with the correct glassware. An inverted funnel leading to a condenser is placed above a beaker of salt water. The beaker is then heated, and the water will evaporate into the condenser. It will then cool back to liquid, and can be caught by a beaker at the other end of the condenser, providing clean fresh water. Students then discuss the benefits and drawbacks of desalination. Things to consider include the abundance of salt water, cost, energy usage and necessity.



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## Additional activity: Using water in agriculture

Agriculture is one of the greatest users of fresh water in Australia. Students can research methods to reduce water use on farms. These include drip irrigation, no-till farming, water efficient crops and computer-controlled watering systems.

## Additional activity: From salty to fresh

Ask students to find out the names of countries that use desalination for their fresh water supply. What do they have in common? Where is desalination used in Australia?

## Additional activity: Researching recycling water at Toowoomba

Research the Toowoomba debate over water recycling. Assign different teams of students to find out why there was a water shortage, what process was proposed for recycling the water, whether recycled water would be safe for drinking, and why the proposal was rejected. Have each group present their part of the story to the class so that the whole class gets the full picture. This may be followed with a debate about whether you would be willing to drink recycled water.

## Ethical behaviour

Considering that Australia is the driest populated continent on Earth, it should surprise students to hear that Australians are one of the highest users of water per person in the world. Ask students to research the new initiatives that the Australian Government has put in place to save water. How does our use of water affect the global water cycle?

## Going further

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

**Department of the Environment**

This government website contains information about water management including the Murray–Darling Basin Plan.



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# 4.4 Water is a precious resource

## Teacher notes (pages 72–73)

### Introducing the topic

This section investigates how much usable water is available on Earth. When you see the Earth from space, it seems so blue, and that water is so readily available. However, when you investigate further it is surprising to discover that only 0.007 per cent of the Earth's water is available for drinking. That's not much at all!

### Teaching tip: Additional information

Australians are among the biggest water users in the world, despite living on the driest continent. Two-thirds of Earth's population uses less than 60 litres of water per day, while Australians use more than twice that in the average shower and use about 340 litres per day. The drought in 2003–09 prompted the introduction of water-saving programs ranging from low-flow shower heads to rainwater tanks. Water restrictions were also enforced in most areas.

The Australian dual flush toilet saves up to 67 per cent of water when compared to a traditional toilet. The original 1980 Caroma design saved 32 000 litres of water per household. Designs have been further refined. In a drought-affected country, dual-flush toilets have been made compulsory in most Australian states.

### Teaching tip: Recycled water

The greatest misconception people have is that recycled water is unfit for drinking. This shows that they have little understanding of the natural water cycle, in which water is constantly recycled. This controversy was played out in 2006 in Toowoomba when residents rejected the introduction of fully treated sewage back into drinking water supplies. Despite the continued unpopularity of this option in Australia, the practice is used successfully overseas in many forms. Water recycling in Australian communities involves dual systems where treated effluent is used for industry, gardens or toilets. Treated effluent is also discharged into rivers that eventually feed the drinking water reservoirs of some cities.

The process of distillation was used in early desalination plants, but modern plants use reverse osmosis. A virtual tour of the Sydney Desalination Plant can be taken at the Sydney Water website. The process of desalination requires great amounts of electricity, and has been criticised for this reason.



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## Additional activity: Monitoring water quality with Waterwatch

You can help Waterwatch by taking some measurements at your local waterway. Tests include turbidity and pH. Many schools have water-testing equipment available and if not, equipment can be made (for example the turbidity meter). Visit the Waterwatch website for more information on how to become involved.

## Additional activity: Saving water

Ask students to list all of the ways they already save water at home and at school. They should include water-saving devices such as dual flush toilets, low-flow shower heads and rainwater tanks. When the obvious options have been considered, bring up options such as drought-resistant plants for the garden, washing the car infrequently, mulching the garden, and using a dishwasher rather than washing dishes by hand. Create a master list of the ways in which everyone conserves water.

## Additional activity: Why do we need water?

Students can look at their home water bill. How much does water cost per litre? How much does bottled water cost compared to tap water? The average household uses about 900 litres per day – how does their water use compare to this average? Students will have to make calculations to answer these questions.

For students with lower abilities, provide a scaffolded worksheet to assist with calculations. Water bills generally provide an average daily usage in litres as well as the price of water per kilolitre (1000 litres). Use the teacher's water bill as an example for calculations if students cannot get the information from home.

Higher ability students can calculate additional savings that may be made by installing low-flow shower heads, having shorter showers, installing rainwater tanks for toilets and laundry, and so on.

## Additional activity: Desalination plants

Desalination refers to removing salt from water in order to make it usable and/or drinkable. Desalination plants already exist in Australia, but their use is controversial.

As an extension activity, students could research desalination plants and investigate the pros and cons of their use.



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# Suggested teaching program

## Chapter 3: Water

Time allocation: 3 weeks

| **Context and overview** |
|---|
| In year 7, students use and develop models such as the water cycle to represent and analyse the flow of matter through ecosystems and explore the impact of changing components within the water cycle. Students make accurate measurements and control variables to analyse relationships between system components and explore and explain these relationships through increasingly complex representations. |
| **Syllabus outcomes addressed** |
| • Water is an important resource that cycles through the environment VCSSU101<br>• Scientific knowledge and understanding of the world changes as new evidence becomes available; science knowledge can develop through collaboration and connecting ideas across the disciplines and practice of science VCSSU089<br>• 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 VCSSU090<br>• Identify questions, problems and claims that can be investigated scientifically and make predictions based on scientific knowledge VCSIS107<br>• Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed VCSIS108<br>• In fair tests, measure and control variables, and select equipment to collect data with accuracy appropriate to the task VCSIS109<br>• Construct and use a range of representations including graphs, keys and models to record and summarise data from students' own investigations and secondary sources, and to represent and analyse patterns and relationships VCSIS110<br>• 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 VCSIS112<br>• Communicate ideas, findings and solutions to problems including identifying impacts and limitations of conclusions and using appropriate scientific language and representations VCSIS113 |
| **Achievement standards** |
| Students analyse how the sustainable use of resources depends on the way they are formed and cycle through Earth system. Students describe situation where scientific knowledge from different science disciplines had been used to solve a real-world problem They explain how water as a resource is viewed by, and impacted on, different groups in society. Students identify questions that can be investigated scientifically. They plan fair experimental methods, identifying variables to be changed and measured. They select equipment that improves fairness and accuracy and describe how they considered safety. Students draw on evidence to support their conclusions. They summarise data from different sources, describe trends and refer to the quality of their data when suggesting improvements to their methods. They communicate their ideas, methods and findings using scientific language and appropriate representations. |


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| Student book section | VIC Syllabus links | Suggested indicators of learning and understanding | Suggested teaching and learning activities | Resources |
|---|---|---|---|---|
| **4.1 Water cycles through the environment**<br><br>**(pages 66–67)** | *Science Understanding*<br>VCSSU101<br><br>*Science as a Human Endeavour*<br>VCSSU090<br><br>*Science Inquiry Skills*<br>VCSIS107<br>VCSIS108<br>VCSIS109<br>VCSIS110<br>VCSIS112<br>VCSIS113 | By the end of this unit, students should be able to:<br>• define evaporation, condensation, precipitation and transpiration<br>• describe the water cycle<br>• relate aspects of the water cycle to human behaviours. | **Experiment 4.1**<br>*What if the temperature were increased in the water cycle?*<br>Students design and make a model of the water cycle and investigate the effect of changing temperature on the cycle.<br><br>**Animated water cycles**<br>Students can watch the animated water cycle or complete the hydrological cycle tutorial and either critique the existing tutorials, write additional questions or create their own animation/tutorial. | **Oxford Science 7 Victorian Curriculum resources**<br>• Check your learning, page 67<br>• Experiment 4.1, page 199<br><br>**Additional resources**<br>A basic narrated and animated explanation of the water cycle.<br>http://www3.epa.gov/safewater/kids/flash/flash_watercycle.html<br><br>A more in-depth tutorial about the hydrological cycle, including quiz questions, can be found at:<br>http://www.sciencecourseware.com/eec/GlobalWarming/Tutorials/HydrologicalCycle/ |
| **4.2 Factors in nature affect the water cycle**<br><br>**(pages 68–69)** | *Science Understanding*<br>VCSSU101<br><br>*Science as a Human Endeavour*<br>VCSSU089<br><br>*Science Inquiry Skills*<br>VCSIS113 | By the end of this unit, students should be able to:<br>• describe the characteristic conditions of El Nino and La Nina in Australia<br>• explain how El Nino and La Nina affect the water cycle in Australia<br>• explain how volcanic eruptions can affect the water cycle. | **Investigating El Nino**<br>Students can use real data in the form of various graphs and charts to investigate El Nino.<br><br>**El Nino and La Nina**<br>Students can watch a short documentary that provides more detail about these weather patterns. | **Oxford Science 7 Victorian Curriculum resources**<br>• Check your learning, page 69<br><br>**Additional resources**<br>The five data in the classroom activities use real data to investigate El Nino.<br>http://dataintheclassroom.noaa.gov/SitePages/el-nino/index#.VhxPTBOqqkp<br><br>National Geographic video about El Nino and La Nina<br>http://education.nationalgeographic.com.au/activity/the-ocean-and-weather-el-nino-and-la-nina/ |

| | | | | |
|---|---|---|---|---|
| **4.3 Human management affects the water cycle**<br><br>**(pages 70–71)** | *Science Understanding*<br>VCSSU101<br><br>*Science as a Human Endeavour*<br>VCSSU089<br>VCSSU090<br><br>*Science Inquiry Skills*<br>VCSIS107<br>VCSIS108<br>VCSIS110<br>VCSIS112<br>VCSIS113 | By the end of this unit, students should be able to:<br><br>• define distillation<br>• describe how the water cycle is important to agricultural, industrial and domestic use of water<br>• provide examples of how agriculture, industry and domestic behaviour can alter the water cycle. | **Challenge 4.3**<br>*Can you reduce the evaporation of water in irrigation channels?*<br>Students investigate methods of reducing evaporation and apply their findings to calculate the costs of applying their ideas in a real life situation.<br><br>**Build a model desalination plant**<br>Students can use the information provided on the Teach Engineering website to build a functional model of a desalination plant. | **Oxford Science 7 Victorian Curriculum resources**<br>• Check your learning, page 71<br>• Challenge 4.3, page 200<br><br>**Additional resources**<br>Teach Engineering desalination model building.<br>https://www.teachengineering.org/view_activity.php?url=collection/cub_/activities/cub_desal/cub_desal_lesson01_activity2.xml |
| **4.4 Water is a precious resource**<br><br>**(pages 72–73)** | *Science Understanding*<br>VCSSU101<br><br>*Science as a Human Endeavour*<br>VCSSU090<br><br>*Science Inquiry Skills*<br><br>VCSIS113 | By the end of this unit, students should be able to:<br><br>• define sustainable<br>• provide examples of how water is used around the home<br>• explain how little drinking water is available to people. | **Promoting water saving**<br>Student can watch the water saving tips from the *savewater* website and either make their own videos to promote water saving around school, or develop their own water saving campaign. | **Oxford Science 7 Victorian Curriculum resources**<br>• Extend your understanding, page 73<br><br>**Additional resources**<br>Weblink for water saving tips around the home<br>http://www.melbournewater.com.au/getinvolved/saveandreusewater/pages/save-water-at-home.aspx |



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| | | | | |
|---|---|---|---|---|
| **4 Review**<br><br>**(pages 74–75)** | *Science Understanding*<br>VCSSU101<br><br>*Science as a Human Endeavour*<br>VCSSU090<br><br>*Science Inquiry Skills*<br><br>VCSIS113 | By the end of this unit, students should be able to:<br><br>• define all key words listed on page 76<br>• explain how important water is to life on Earth and how it cycles through the environment<br>• identify areas of personal strengths and weaknesses in their knowledge and understanding of the topic. | **Revision activities**<br>• Students could play celebrity heads with the key words list.<br>• Students can make dominoes with Key Words on one end and definitions/diagrams/examples on the other end.<br>• Students can create mind maps, Venn diagrams or other graphic organisers to summarise the key concepts of this chapter.<br>• 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 Victorian Curriculum resources**<br>• Review questions, pages 74–75<br>• Research topics, page 75<br>• Key words list, page 76 |


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# Chapter 4: Sound and light

## 4.1 Vibrating particles pass on sound

## Teacher notes (pages 64–65)

### 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 66–67)

### 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 68–69)

### 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.



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## 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.



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# 4.4 Ears can be replaced

## Teacher notes (pages 70–71)

### 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 72–73)

### 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

## 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 74–75)

### 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 76–77)

### 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 78–79)

### 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 80–81)

### 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.



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## 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.



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# 4.10 Our eyes detect light

## Teacher notes (pages 82–83)

### 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.



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# 4.11 Things can go wrong with our eyes

## Teacher notes (pages 84–85)

### 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.

**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 8, 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 appears in different forms including movement (kinetic energy), heat, light, chemical energy and potential energy; devices can change energy from one form to another VSSU104<br>• Scientific understanding, including models and theories, are contestable and are refined over time through a process of review by the scientific community VCSSU114<br>• Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries VCSSU115<br>• Use scientific knowledge and findings from investigations to identify relationships, evaluate claims and draw conclusions VCSIS111<br>• The values and needs of contemporary society can influence the focus of scientific research VCSSU116<br>• Independently plan, select and use appropriate investigation types, including fieldwork and laboratory experimentation, to collect reliable data, assess risk and address ethical issues associated with these investigation types VCSIS135<br>• Select and use appropriate equipment and technologies to systematically collect and record accurate and reliable data, and use repeat trials to improve accuracy, precision and reliability VCSIS135<br>• Analyse patterns and trends in data, including describing relationships between variables, identifying inconsistencies in data and sources of uncertainty, and drawing conclusions that are consistent with evidence VSIS138<br>• Use knowledge of scientific concepts to evaluate investigation conclusions, including assessing the approaches used to solve problems, critically analysing the validity of information obtained from primary and secondary sources, suggesting possible alternative explanations and describing specific ways to improve the quality of data VCSIS139<br>• Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations VCSIS140 |
| **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.<br>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. |

| Student book section | VIC Syllabus links | Suggested indicators of learning and understanding | Suggested teaching and learning activities | Resources |
|---|---|---|---|---|
| **4.1 Vibrating particles pass on sound**<br><br>**(pages 64–65)** | *Science Understanding*<br>VCSSU104<br><br>*Science as a Human Endeavour*<br>VCSSU114<br><br>*Science Inquiry Skills*<br>VCSIS135<br>VCSIS139<br>VCSIS140 | By the end of this unit, students should be able to:<br>• Define compression, rarefaction, longitudinal wave, amplitude, wavelength, frequency and hertz<br>• Describe the motion of molecules in a longitudinal wave<br>• Relate wavelength to frequency and pitch | **What if?**<br>Students investigate the transference of sound through a medium (string phone).<br><br>**Challenge 4.1**<br>*Modelling sound waves*<br>Students model compressions and rarefactions of a longitudinal wave using a slinky.<br><br>**Properties of sound**<br>Students can learn more about the main properties of sound; frequency, pitch and timbre, and longitudinal waves by watching the UNSW clips. | **Oxford Science 8 Victorian Curriculum resources**<br>• What if? Page 63<br>• Check your learning, page 65<br>• Challenge 4.1, page 190<br><br>**Additional resources**<br>UNSW Physclips – Sound:<br>http://www.animations.physics.unsw.edu.au/waves-sound/sound/index.html<br>- 4.1 Properties of sound<br>- 4.2 Longitudinal waves |
| **4.2 Sound can travel at different speeds**<br><br>**(pages 66–67)** | *Science Understanding*<br>VCSSU104<br><br>*Science Inquiry Skills*<br>VCSIS135<br>VCSIS136<br>VCSIS138<br>VCSIS139<br>VCSIS140 | By the end of this unit, students should be able to:<br>• Explain why sound does not travel through space<br>• Relate the transmission of sound to the density of particles of the medium through which it travels | **Challenge 4.2A**<br>*The speed of sound*<br>Students investigate the speed of sound and consider the reliability of data.<br><br>**Challenge 4.2B**<br>*Racing dominoes*<br>Students model the differences in the speed of sound in different mediums using dominoes.<br><br>**The speed of sound**<br>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 8 Victorian Curriculum resources**<br>• Check your learning, page 67<br>• Challenge 4.2A, page 191<br>• Challenge 4.2B, page 191<br><br>**Additional resources**<br>UNSW Physclips – Sound:<br>http://www.animations.physics.unsw.edu.au/waves-sound/sound/index.html<br>- 4.5 Speed of sound |

 
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| **4.3 Our ears hear sound**<br><br>**(pages 68–69)** | *Science Understanding*<br>VCSSU104<br><br>*Science as a Human Endeavour*<br>VCSSU114<br><br>*Science Inquiry Skills*<br>VCSIS135<br>VCSIS139<br>VCSIS140 | By the end of this unit, students should be able to:<br>• Identify the key structures of the ear and describe their function in detecting sound<br>• Describe the processes involved in the detection of sound | **Experiment 4.3**<br>*Why do we need ears?*<br>Students investigate the purpose of two ears.<br><br>**Structure and function of the ear**<br>Students can investigate the specific structures and their functions within the human ear with the Interactive Ear website. | **Oxford Science 8 Victorian Curriculum resources**<br>• Check your learning, page 69<br>• Experiment 4.3, page 192<br><br>**Additional resources**<br>The Interactive Ear:<br>http://www.amplifon.co.uk/interactive-ear/index.html |
| **4.4 Ears can be replaced**<br><br>**(pages 70–71)** | *Science Understanding*<br>VCSSU104<br><br>*Science as a Human Endeavour*<br>VCSSU115<br>VCSSU116<br><br>*Science Inquiry Skills*<br>VCSIS135<br>VCSIS136<br>VCSIS138<br>VCSIS139<br>VCSIS140 | By the end of this unit, students should be able to:<br>• Define decibels<br>• Describe the symptoms of tinnitus<br>• Explain the purpose of a cochlear implant<br>• Relate technological and scientific developments with the needs of society | **Challenge 4.4**<br>*Is school bad for your health?*<br>Students investigate sound pollution at school.<br><br>**Tinnitus**<br>Students can investigate tinnitus in Australia, some of its causes and listen to representations of the symptoms and the Australian Tinnitus Association website.<br><br>**The history of cochlear implants**<br>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 8 Victorian Curriculum resources**<br>• Extend your understanding, page 71<br>• Challenge 4.4, page 192<br><br>**Additional resources**<br>Australian Tinnitus Association:<br>http://www.tinnitus.asn.au/tinnitus.htm<br><br>Time Toast – History of Cochlear Implants:<br>https://www.timetoast.com/timelines/history-of-cochlear-implants |



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| **4.5 Visible light is a small part of the electromagnetic spectrum**<br><br>**(pages 72–73)** | *Science Understanding*<br>VCSSU104<br><br>*Science as a Human Endeavour*<br>VCSSU114<br>VCSSU115<br><br>*Science Inquiry Skills*<br>VCSIS135<br>VCSIS139<br>VCSIS140 | By the end of this unit, students should be able to:<br>• Define transverse waves<br>• Describe the motion of particles in a transverse waves<br>• List the classes of electromagnetic radiation and their average wavelengths<br>• Explain how light behaves as a wave and how it behaves as a particle | **Challenge 4.5**<br>*Modelling light waves*<br>Students model transverse waves with a slinky considering wavelength, frequency and amplitude.<br><br>**The speed of light**<br>Students can investigate how to measure the speed of light by watching the experiment on the UNSW clip. | **Oxford Science 8 Victorian Curriculum resources**<br>• Check your learning, page 73<br>• Challenge 4.5, page 193<br><br>**Additional resources**<br>UNSW Physclips – The nature of light of light:<br>http://www.animations.physics.unsw.edu.au/light/nature-of-light/<br>- 1.3 The speed of light |

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| **4.6 Light reflects off a mirror**<br><br>**(pages 74–75)** | *Science Understanding*<br>VCSSU104<br><br>*Science as a Human Endeavour*<br>VCSSU114<br><br>*Science Inquiry Skills*<br>VCSIS135<br>VCSIS136<br>VCSIS138<br>VCSIS139<br>VCSIS140 | By the end of this unit, students should be able to:<br>• Define transparent, translucent, opaque, image, mirror, normal, angle of incidence, angle of reflection, virtual image, convex and concave<br>• Describe the relationship between the angle of incidence, normal and angle of reflection<br>• Describe the characteristics of a virtual image<br>• Demonstrate appropriate use of a Hodson light box<br>• Calculate the angle of reflection from the angle of incidence | **Skills Lab 4.6**<br>*Using a Hodson light box*<br>Students develop skills to use a Hodson light box and to draw ray diagrams.<br><br>**Experiment 4.6**<br>*Reflection from plane mirrors*<br>Students investigate the law of reflection using a Hodson light box and ray diagrams.<br><br>**Challenge 4.6A**<br>*Mirror writing*<br>Students investigate perception of reflected light through a number of activities involving the use of a mirror.<br><br>**Challenge 4.6B**<br>*Using curve mirrors*<br>Students investigate reflection in concave and convex mirrors using a Hodson light box.<br>**Mirrors and images**<br>Student can learn more about reflection in different types of mirrors and the differences between virtual and real images in the UNSW webpage. | **Oxford Science 8 Victorian Curriculum resources**<br>• Check your learning, page 75<br>• Experiment 4.6, page 195<br>• Challenge 4.6A, page 195<br>• Challenge 4.6B, page 196<br>• Skills Lab 4.6, page 194<br><br>**Additional resources**<br>UNSW Physclips – Mirrors and images: http://www.animations.physics.unsw.edu.au/jw/light/mirrors-and-images.htm |

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| **4.7 Light refracts when moving in and out of substances**<br><br>**(pages 76–77)** | *Science Understanding*<br>VCSSU104<br><br>*Science as a Human Endeavour*<br>VCSSU114<br><br>*Science Inquiry Skills*<br>VCSIS135<br>VCSIS136<br>VCSIS138<br>VCSIS139<br>VCSIS140 | By the end of this unit, students should be able to:<br>• Define refraction, medium, refractive index, refracted ray, angle of refraction, lens, converge, focus, focal length, diverge and virtual focus<br>• Describe the refraction of light through a convex and concave lens<br>• Explain the difference between focus and virtual focus<br>• Relate the direction of refraction to the change in density of mediums<br>• Demonstrate appropriate use of a Hodson light box | **Experiment 4.7A**<br>*Bending of light*<br>Students investigate refraction of light through Perspex blocks using a Hodson light box.<br><br>**Experiment 4.7B**<br>*Creating images with convex lenses*<br>Students investigate refraction of light through a convex lens and consider the variable of focal length. | **Oxford Science 8 Victorian Curriculum resources**<br>• Check your learning, page 77<br>• Experiment 4.7A, page 196<br>• Experiment 4.7B, page 197 |
| **4.8 Different wavelength of light are different colours**<br><br>**(pages 78–79)** | *Science Understanding*<br>VCSSU104<br><br>*Science as a Human Endeavour*<br>VCSSU114<br>VCSSU115<br><br>*Science Inquiry Skills*<br>VCSIS135<br>VCSIS136<br>VCSIS139<br>VCSIS140 | By the end of this unit, students should be able to:<br>• Define visible spectrum, dispersion, primary colours of light, secondary colours of light, filters and transmit<br>• Describe how we see the colour of opaque and transparent objects<br>• Relate the secondary colours of light to the primary colours of light<br>• Demonstrate appropriate use of a Hodson light box | **Experiment 4.8**<br>*What colour is it?*<br>Students investigate the different colours of light, both primary and secondary, using coloured filters and a Hodson light box.<br><br>**Colour Vision Simulator**<br>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 8 Victorian Curriculum resources**<br>• Check your learning, page 79<br>• Experiment 4.8, page 198<br><br>**Additional resources**<br>PHET Colour Vision simulator:<br>https://phet.colorado.edu/sims/html/color-vision/latest/color-vision_en.html |



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| **4.9 The electromagnetic spectrum has many uses**<br><br>**(pages 80–81)** | *Science Understanding*<br>VCSSU104<br><br>*Science as a Human Endeavour*<br>VCSSU115<br>VCSIS111<br>VCSSU116<br><br>*Science Inquiry Skills*<br>VCSIS135<br>VCSIS136<br>VCSIS139<br>VCSIS140 | By the end of this unit, students should be able to:<br>• Define critical angle, total internal reflection and optic fibre<br>• Describe how optic fibres and microwave ovens work<br>• Relate the critical angle with total internal reflection | **Experiment 4.9**<br>*What is the wavelength of a microwave?*<br>Students investigate the wavelength of microwaves.<br><br>**Using the electromagnetic spectrum**<br>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 8 Victorian Curriculum resources**<br>• Extend your understanding, page 81<br>• Experiment 4.9, page 199 |

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| **4.10 Our eyes detect light**<br><br>**(pages 82–83)** | *Science Understanding*<br>VCSSU104<br><br>*Science Inquiry Skills*<br>VCSIS135<br>VCSIS136<br>VCSIS139<br>VCSIS140 | By the end of this unit, students should be able to:<br>• Define pupil, cornea, lens, retina and optic nerve<br>• Identify the main structures of the human eye and describe their functions<br>• Explain how an image forms on the retina | **Challenge 4.10**<br>*Vision tests*<br>Students investigate the function of the human eye, including focal length, depth perception and blind spots, through a number of activities.<br><br>**Experiment 4.10**<br>*Eye dissection*<br>Students develop their dissection skills and investigate the structure of a mammalian eye.<br><br>**The eye as a lens**<br>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.<br>**Extension – Rods and cones**<br>Students can learn more about how the eye detects wavelength and intensity of light using photoreceptors. | **Oxford Science 8 Victorian Curriculum resources**<br>• Check your learning, page 83<br>• Experiment 4.10, page 200<br>• Challenge 4.10, page 202<br><br>**Additional resources**<br>UNSW Physclips – The eye and colour vision:<br>http://www.animations.physics.unsw.edu.au/light/eye-colour-vision/<br>- 3.1 Anatomy and function<br>- 3.2 Retina, rods and cones |
| **4.11 Things can go wrong with our eyes**<br><br>**(pages 84–85)** | *Science Understanding*<br>VCSSU104<br><br>*Science as a Human Endeavour*<br>VCSSU115<br>VCSSU116<br><br>*Science Inquiry Skills*<br>VCSIS135<br>VCSIS139<br>VCSIS140 | By the end of this unit, students should be able to:<br>• Define short-sighted, myopia, long-sighted, hyperopia, colour-blindness, cataracts and astigmatism<br>• Provide examples of disease and problems that affect the eyes and vision<br>• Explain how short- and long-sightedness can be corrected with lenses<br>• Relate colour-blindness to the function of photoreceptors | **Challenge 4.11**<br>*Make a jelly lens for your smartphone*<br>Students apply their understanding of the behaviour of light to produce a lens for their phone camera.<br><br>**Corrective lenses in action**<br>Students can investigate how corrective lenses work on different eye conditions with the comparative animations at the Zeiss website. | **Oxford Science 8 Victorian Curriculum resources**<br>• Check your learning, page 85<br>• Challenge 4.11, page 203<br><br>**Additional resources**<br>Zeiss Vision Animations:<br>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**<br><br>**(pages 86–88)** | *Science Understanding*<br>VCSSU104<br><br>*Science Inquiry Skills*<br>VCSIS140 | By the end of this unit, students should be able to:<br>• Define all Key Words listed on page 88<br>• Explain the transfer of energy through different mediums using wave and particle models<br>• Identify areas of personal strengths and weaknesses in their knowledge and understanding of the topic | **Revision activities**<br>• Students could play celebrity heads with the Key Words list<br>• Students can make dominoes with Key Words on one end and definitions/diagrams/examples on the other end<br>• Students can create mind maps, Venn diagrams or other graphic organisers to summarise the key concepts of this chapter<br>• 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 Victorian Curriculum resources**<br>• Review questions, pages 86–87<br>• Research topics, page 87<br>• Key Words list, page 88 |



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# Chapter 4: Tectonic plates

## 4.1 Is the Earth shrinking or moving?

## Teacher notes (pages 72–73)

### Introducing the chapter

The chapter begins with an outline of the development of the theory of plate tectonics. The observations and evidence that support this theory are described. The underlying mechanisms that drive plate tectonics are then illustrated. Classic examples of geology associated with plate tectonics are used to illustrate the features of a planet whose crust is divided into moving plates. The different types of plate boundaries are then explored, along with some of the natural disasters that are associated with them.

### Teaching tip: Palaeomagnetism

One of the most compelling pieces of evidence supporting the idea of sea-floor spreading is the detection of alternating palaeomagnetism in the volcanic rocks of the sea floor. The direction of the Earth’s magnetic field is stored in a volcanic rock as it solidifies and cools. This means volcanic rocks carry a remnant magnetic field from the time they formed. This remnant field can be measured in the rocks of the sea floor and, when this is done, a surprising pattern is observed.

The remnant magnetism in the sea floor alternates from one direction to another as you move away from a mid-ocean ridge. This pattern is repeated on the opposite side of the ridge, as you move away in the opposite direction. The Earth’s magnetic field is known to change direction by approximately 180° every few thousand years. When the polarity of the Earth’s magnetic field switches, the segment of the sea floor formed over several thousand years records the direction of the field. When the polarity switches again, the next few thousand years of formation contains a remnant field in the opposite direction. The detection of this alternating pattern mirrored on both sides of the mid-ocean ridge indicates that the sea floor is spreading away from the mid-ocean ridge.

The alternating remnant magnetism of the sea floor can be modelled by having two pieces of paper diverge from each other out of the small gap between the tops of two desks. As the paper comes onto the top of the desk, colour both pieces the same colour for some time, representing remnant magnetism in one direction. Then for a similar time use another colour, representing remnant magnetism in the other direction. This activity, coupled with images representing the sea floor’s palaeomagnetism, should clarify the idea of sea floor spreading in the minds of the students, as it does in the minds of scientists.

 
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## Additional activity: Geological time

The study of geology often requires some concept of the age of the Earth and an appreciation of the time scales involved. A quick introductory activity that may be useful is to map out the history of the Earth compressed into the time scale of one Earth year. There are many examples of this sort of activity that can be found online. It will become clear to students that even the entire history of our species is just a single moment compared with the geological time scale.

## Additional activity: Plate tectonic animations

Animations and images that convey the evidence that supports the theory of plate tectonics are especially useful here. There are many images and animations available online.

One way of approaching this section would be to get students to explore these animations and have them write detailed descriptions of what is occurring at each type of plate boundary. This is a great opportunity for students to practise writing text from a visual stimulus.

## Additional activity: Plate tectonics and continental drift

Often students imagine that tectonic plates map directly onto the shapes of the continents, and so can become confused when we refer to the supercontinent splitting as the coastlines do not fit perfectly. This is because some of the plate boundaries are beneath the oceans and also there has been significant coastal erosion over the years. Little is known about why the plates broke up in the way that they did and there is opportunity here to hypothesise about how these plates may behave in the future.

Research into some of the following areas may help to cement these concepts. What answers do scientists currently have to the following questions?

- Will the plates break up even more into smaller plates?
- Have the plates ever combined into larger plates?
- Why do the plates move at different speeds from each other?
- Do the plates always move in the same direction or have they changed course?
- Is there another theory competing with the tectonic plate theory to explain aspects of the Earth’s surface behaviour?

Although these questions are very difficult to answer definitively, the ideas explored will support the students’ conceptual understanding.

Students often use the terms ‘continental drift’ and ‘plate tectonics’ to mean the same thing. It is worth clarifying that the continents are surface land masses and tectonic plates are the things that are actually moving.



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Students could research early explanations for how similar fossils and flightless birds could appear on different continents, before Wegener produced his theory.

## Assessment

Suggested further research could be directed into the way that plates are classified into primary, secondary and tertiary plates. This, in essence, is a classification of plates into groups within which there are low levels of relative movement. This will lead some students to refer to either the Indo-Australian Plate in their answers or the Indian Plate or Australian Plate, depending on their depth of research.

## Going further

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

**Video: Continental drift**

This video on the Science Channel website explains the origins of Wegener's theory of continental drift.



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# 4.2 The Earth has a solid core

## Teacher notes (pages 74–75)

### Introducing the topic

The Earth is made of several layers. We live on the crust, under the crust is the molten rock that makes up the mantle. In this section, students further investigate the layers of the Earth and how these can result in movements in the Earth's surface.

### Teaching tip: The internal structure of the Earth

At an appropriate place in this topic it may be necessary to review the internal structure of the Earth. Students will need to relate the layers of the Earth to one another in their work on plate tectonics.

### Teaching tip: Terminology

Students often use the terms 'continental drift' and 'plate tectonics' to mean the same thing. It is worth clarifying that the continents are surface land masses, whereas the tectonic plates are the things that are actually moving.

### Teaching tip: Convection

Now would be a good time to revise the concept of density because it is fundamental to an explanation of convection. The reason for the change in density with temperature comes from an understanding of the particle theory of matter. This theory is introduced in previous year levels. It would be useful to revisit it because it will refresh and strengthen students' understanding.

### Teaching tip: Magma

It is often taught that gravity and convection are the two driving forces behind plate tectonics, but that is not the whole story. The pressure from magma erupting and forming new oceanic crust at the mid-ocean ridges also exerts a force on the diverging plates.

### Teaching tip: Plate tectonics

It is common in education to make simplifications or generalisations. In saying that gravity and convection are the two driving forces behind plate tectonics, we are focusing on the most significant causes. It is impractical to include every single minute detail in everything we teach, but it is also important to make students aware that the reality of the physical world is very complex. To introduce and illustrate this point, get students to propose other contributions to a phenomenon like plate tectonics. It may frustrate them, and they may not get it right, but they need to experience taking a chance and generating their own ideas.

When students do come up with their own ideas, the scientific method shows us how to decide whether it is a good idea or not. Can it be tested? If so, does the evidence support the idea? The importance of evidence in making a decision is the key. A flow chart illustrating the method can be useful when working through an idea in this way.

## Differentiation

For less able students:

The large amount of new vocabulary used in this topic can often be a hurdle. Using activities such as find-a-word, crosswords and other activities where students use the terminology and refine their understanding of it would be helpful.

For more able students:

A higher-order verb could be used for questions for more able students. If a description is required, then students who find this easy could also be asked to explain what is happening.

## Additional activity: What is the Earth made of?

There are many opportunities here to engage students in creatively working with scientific knowledge. These are some possible activities for students:

- Critique a movie concerned with journeying to the centre of the Earth.
- Produce scaled diagrams of the relative thickness or temperatures of each layer of the Earth.
- Investigate why different layers are different densities and/or temperatures.
- Consider why there is so much water on the surface of Earth if it is a cooling mass of molten rock.

## Additional activity: Where in the world are tectonic plates?

Students could research where in the world tectonic plates are found and then note any similarities about what occurs near plate boundaries. Students should be encouraged to debate their theories or perform some research and present some definitive findings to the group. Some suggested responses are below:

- Many volcanoes are found on plate boundaries.
- Significant eruptions causing death have occurred on plate boundaries.
- The majority of volcanic activity is evident on converging rather than diverging boundaries.
- Australian volcanoes could have formed along secondary/tertiary plate boundaries and where the crust has experienced changing pressures and thinning.



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- Maps clearly show why there are so many hot springs in New Zealand and why it has suffered recently from earthquakes.
- Maps should stimulate discussion of the Pacific Ring of Fire, the site of most of the world's active volcanoes.



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# 4.3 Boundaries between the tectonic plates can be converging, diverging or transforming

## Teacher notes (pages 76–79)

### Introducing the topic

This section explores how the movement of tectonic plates causes the Earth to change – mountains form, new sea floor appears, earthquakes occur and volcanoes erupt. The terms ‘converge’, ‘diverge’ and ‘transform’ are introduced.

### Teaching tip: Converging boundaries

The concept of density is very important here if students are to really understand the differences in plate convergence. The fact that a denser material has more matter/particles for any given size/volume means that when it moves towards a less dense material, it will be more difficult to lift up, so it will ‘burrow’ underneath. Oceanic plates, in particular older ones, are much denser than continental plates. If the plates are equally matched in terms of density than neither will burrow under and so both will buckle.

### Teaching tip: Geology as a career

Most people would think that a geologist is someone who sits in a laboratory and plays with rocks. They would also think that when a geologist is not in the laboratory, they are out collecting more rocks to bring back to the laboratory. Although a knowledge of rocks and the collection of samples would be part of a geologist’s job, there is much more to their work.

It is important to know that geologists do not work in isolation and that no one technique or technology tells them all they need to know: they have colleagues who specialise in chemistry to analyse rocks; they work with geophysicists who specialise in using technology to extract data from deep within the Earth and determine the properties of the rocks. Other collaborators specialise in computer modelling to simulate geological processes and make predictions.

Scientists always collaborate with others. Each of the collaborators brings their particular expertise to the research that is being conducted. They all play their part in conducting the research and reporting the findings in a publication. It is important for scientists to establish connections with others who can collaborate with them. They must communicate with their colleagues and then communicate their findings to the broader scientific community

### Teaching tip: Divergent boundaries in the sea

Divergent boundaries are some of the most active on Earth, but most of them are hidden from our view at the bottom of the ocean. There are many examples of rift valleys on continents, including the one that shapes the landscape of Hobart in Tasmania, but the most impressive and active is the

 
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example in Africa. Many of the smaller examples were formed as larger examples broke continents into pieces and carried them apart.

## Additional activity: Transform boundaries

The regions of the Earth that lie along transform boundaries are generally unstable in terms of geological activity. Whichever boundary we look at, there is always some relative movement. These movements are either moving together/apart or sliding. Time spent explaining the meaning of ‘converging’ and ‘diverging’ will pay off when applying these terms to plate movement. Also the word ‘transform’ should be broken down and students informed that ‘trans’ means ‘across’. This will help remind students that a transform boundary must have an ‘across’ or sliding movement.

## Additional activity: The moving crust

Students could consider why, over time, it is the regions of the crust that are buckled downwards that result in mountain peaks. This is due to the rock buckling up being less dense and so more prone to erosion.

## Going further

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

**Plate tectonics**

This website enables students to explore how plates move on the surface of the Earth.

# 4.4 Tectonic plates can be constructive or destructive

## Teacher notes (pages 80–83)

### Introducing the topic

The movement of tectonic plates occurs over a very long time. A supercontinent takes millions of years to separate. We can't see continents moving because the movement is so slow, but evidence includes fossils and continental plate shape. Earthquakes and volcanoes show us that tectonic plates are constantly on the move.

### Teaching tip: The impact of plate tectonics

Plate tectonics have a more profound impact than most people may think. When a very large earthquake occurs, it can actually affect the rotation of the Earth on its axis. The length of the day sometimes needs to be corrected by a fraction of a second following a large shift in the Earth's crust.

### Teaching tip: Earthquakes causing tsunamis

Japan has become a world leader in the design and manufacture of 'earthquake-proof' large buildings, using a range of technologies and purpose-designed building materials. One such technique is placing a large water tank at the top of a tall building: if an earthquake shakes the building, this then acts as a 'damper', resisting the movement and essentially slowing and reducing the vibrations.

Tsunamis, as the events in Japan in 2011 demonstrated, can be devastating. Tsunamis are often imagined as a single crest moving across the surface of the oceans, when in fact much of the energy being transferred is below the surface and typically there are multiple wave fronts moving together. This energy pulse can move up to 800 km/h when moving through deep water; these may only be 30 cm high but can rise to up to 30 m when slowing as they reach land. This explains why sailors that have been in the path of a tsunami have not noticed it pass by. Reports that these events sound like freight trains passing gives an indication of the enormity of the energy being dissipated as they arrive. It is thought that tsunamis have been caused by meteorites in the past, specifically a tsunami 3.5 billion years ago, which devastated all but the highest mountains.

### Differentiation

The mechanisms behind the different types of volcanoes and earthquakes may require some scaffolding for learners at each end of the spectrum.

For less able students:

 
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The use of models to simulate and demonstrate how earthquakes are produced would be useful. Even something as simple as pressing your hands together and then trying to move them against each other along the length of your hands demonstrates the building of pressure at a transform boundary. Eventually, if you push hard enough, your hands will move against each other with a jolt.

For more able students:

The same activities as above would be useful. Students should be challenged to design, construct or explain models and animations. A comparison of the processes acting in different situations would be possible. Students could also be asked to investigate the factors that cause variations in these situations. These factors would have visible consequences, which the students could explain.

## Additional activity: Seismometer

To bring this section of the topic to life, it would be ideal to see one or more of the devices discussed or model the operation of one of them. A simple seismometer can be made using a hanging pen with weight attached and placing paper beneath its tip. Shaking the paper from side to side simulates the ground shaking in an earthquake. Making a trace of this shaking by moving the paper in one direction at the same time as shaking it from side to side simulates the operation of a simple seismometer. Example seismograms could then be studied and could lead to a discussion of the different waves produced by earthquakes.

## Additional activity: Plates in motion

Organise students into small groups to formulate a theory about which type of plate movement would be the most damaging. Try to limit resources initially and encourage the students to logically construct an argument based on their knowledge to date of plate tectonics.

## Additional activity: Triangulating an epicentre

Many activities can be found online where students use data to triangulate the epicentre of an earthquake from the seismograms recorded at three different seismic stations. Scaffolding is required to assist with all the new technical terms and techniques needed for this activity, but it does demonstrate the work of a seismologist.

## Additional activity: Modelling earthquakes

Earthquakes can be modelled by asking a student to stand next to a whiteboard looking along the board and leaning forwards. As they do this the hand nearest the board should be placed flat against the board, out in front of them to stop them falling forwards. Then ask the student to lean further and further forward until they feel their hand start to slip. This slipping will happen suddenly and they will fall forward. As this happens, the 'static' friction that has held them in place is not enough to maintain the balance and the 'dynamic' (or moving) friction allows a brief acceleration between the objects. This is because dynamic friction is smaller than static friction. It is this process that can be so devastating at converging and transform boundaries.

## Additional activity: Different explanations

The pursuit of scientific knowledge and explanation can often conflict with cultural beliefs and ways of life. Students should consider whether the impact of science has benefited cultures in Hawaii as it has rationalised explanations of previously mystical observations. These cultural impacts could be investigated in New Zealand and Australia.



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# 4.5 What will the Earth look like in the future?

## Teacher notes (pages 84–85)

### Introducing the topic

This section explores the long-term future of the surface of the Earth. The apparently insignificant rate of movement of the tectonic plates over time is explored and future locations predicted. This is a difficult issue for students to embrace because these events are far from immediate. Importantly, it is the study of these patterns that informs our understanding today and they act as predictors for future earthquake regions. The plate movement mechanisms are further examined and links to the Sun's energy supply are made. This can be linked to the discussion of global warming and the impact this will have on the convection currents powering these plates.

### Teaching tip: New technology

The use of new technologies to inform precise rates of plate movement is providing up-to-the-minute data about plate activity and helps seismologists to assess regions of relatively low movement and to predict where sudden transform boundary movements may occur.

There are many models of plate movement into the future; students should be encouraged to consider why these models may not be accurate. For example, can we assume that movement rates will be maintained?

Students may like to explore how humans may adapt to a changing landscape and reflect on how we have evolved to best fit the surface of the Earth as it presently is.

There is scope to link future career paths in science and technology to the findings and research being performed in this area. Links to geology, seismology and the environmental sciences are clear, but students may also consider how engineers can benefit from current research into rock formations and plate movements. For example, there is much collaboration between civil, mechanical, electrical, mathematical and structural engineers in the design and construction of buildings in earthquake regions.

These huge numbers and time spans are beyond comprehension. It can help to draw timelines to the scale of events that have occurred (e.g. extinction of the dinosaurs) and future events that are predicted. The constant shifting and fluidity of the solid rock crust that we live on is quite a conceptual leap.

### Teaching tip: Current events

When teaching this topic it is often good to link the concepts and material to current or recent events, such as volcanic eruptions and earthquakes. This could involve watching short videos from the Internet, reading an article or analysing data or maps from somewhere like the US Geological Survey



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(USGS). Google Earth can also be used to explore the features visible on the surface of the Earth that are associated with geological activity.

Teaching earth science is a great opportunity for students to access multiple sources of information to piece together the big picture. This could be achieved using a jigsaw activity where students in each group become experts in one part.

## Additional activity: Predicting the future

Students could use the information from this chapter and numerical data giving the rates of plate movement to predict what the world may look like at some time in the future. For example, when will some of the countries of South-East Asia meet with Australia? What will form there? Who will our neighbours be?

## Additional activity: Future of the Earth

Research the potential impact human behaviour may have on the future of Earth.

## Going further

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

**NASA – continents in collision: Pangea Ultima**

The NASA website has information and world maps showing what one scientist believes might happen in the future.



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# Suggested teaching program

## Chapter 4: Tectonic plates

Time allocation: 3 weeks

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|---|
| **Context and overview** |
| In year 9, students begin to apply their understanding of energy and forces to global systems including continental movement. |
| **Syllabus outcomes addressed** |
| • The theory of plate tectonics explains global patterns of geological activity and continental movement VCSSU127<br>• Scientific understanding, including models and theories, are contestable and are refined over time through a process of review by the scientific community VCSSU114<br>• Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries VCSSU115<br>• The values and needs of contemporary society can influence the focus of scientific research VCSSU116<br>• Formulate questions or hypotheses that can be investigated scientifically, including identification of independent, dependent and controlled variables VCSIS134<br>• Independently plan, select and use appropriate investigation types, including fieldwork and laboratory experimentation, to collect reliable data, assess risk and address ethical issues associated with these investigation types VCSIS135<br>• Select and use appropriate equipment and technologies to systematically collect and record accurate and reliable data, and use repeat trials to improve accuracy, precision and reliability VCSIS136<br>• Construct and use a range of representations, including graphs, keys, models and formulas, to record and summarise data from students’ own investigations and secondary sources, to represent qualitative and quantitative patterns or relationships, and distinguish between discrete and continuous data VCSIS137<br>• Analyse patterns and trends in data, including describing relationships between variables, identifying inconsistencies in data and sources of uncertainty, and drawing conclusions that are consistent with evidence VCSIS138<br>• Use knowledge of scientific concepts to evaluate investigation conclusions, including assessing the approaches used to solve problems, critically analysing the validity of information obtained from primary and secondary sources, suggesting possible alternative explanations and describing specific ways to improve the quality of data VCSIS139<br>• Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations VCSIS140 |
| **Achievement standards** |
| Students explain global features and events in terms of geological processes and timescales. They predict how future applications of science and technology may affect people’s lives. Students develop questions and hypotheses that can be investigated using a range of inquiry skills. They independently design and improve appropriate methods of investigation including the control and accurate measurement of variables and systematic collection of data. They explain how they have considered reliability, precision, safety, fairness and ethics in their methods and identify where digital technologies can be used to enhance the quality of data. They analyse trends in data, explain relationships between variables and identify sources of uncertainty. When selecting evidence and developing and justifying conclusions, they account for inconsistencies in results and identify alternative explanations for findings. Students evaluate the validity and reliability of claims made in secondary sources with reference to currently held scientific views, the quality of the methodology and the evidence cited. They construct evidence-based arguments and use appropriate scientific language, representations and balanced chemical equations when communicating their findings and ideas for specific purposes. |



| Student book section | VIC Syllabus links | Suggested indicators of learning and understanding | Suggested teaching and learning activities | Resources |
|---|---|---|---|---|
| **4.1 Is the Earth shrinking or moving?**<br><br>**(pages 72–73)** | *Science Understanding*<br>VCSSU127<br><br>*Science as a Human Endeavour*<br>VCSSU114<br>VCSSU115<br><br>*Science Inquiry Skills*<br>VCSIS135<br>VCSIS138<br>VCSIS139<br>VCSIS140 | By the end of this unit, students should be able to:<br>• Define continental drift, continental shelves, sea-floor spreading and plate tectonics<br>• Describe the evidence that support the theory of plate tectonics<br>• Explain the process of sea-floor spreading | **What if?**<br>Students investigate possible interactions between to tectonic plates using clay.<br><br>**Challenge 4.1A**<br>*Reconstructing Pangaea*<br>Students apply their understanding of plate tectonics to reconstruct the shape of Pangaea from modern continents.<br><br>**Challenge 4.1B**<br>*Milo convection currents*<br>Students model the movement of continental plates by convection currents by heating milk and milo.<br><br>**Sea floor spreading**<br>Students can examine the features of a mid-ocean ridge and the process of sea floor spreading with the Earth Guide Online Classroom animation. | **Oxford Science 9 Victorian Curriculum resources**<br>• What if? Page 71<br>• Check your learning, page 73<br>• Challenge 4.1A, page 170<br>• Challenge 4.1B, page 170<br><br>**Additional resources**<br>Earth Guide Online Classroom – Seafloor spreading:<br>http://earthguide.ucsd.edu/eoc/teachers/t_tectonics/p_seafloorspreading.html |



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| **4.2 The Earth has a solid core**<br><br>**(pages 74–75)** | *Science Understanding*<br>VCSSU127<br><br>*Science as a Human Endeavour*<br>VCSSU114<br>VCSSU115<br><br>*Science Inquiry Skills*<br>VCSIS135<br>VCSIS139<br>VCSIS140 | By the end of this unit, students should be able to:<br>• Define crust, mantle, core, tectonic plates and magma<br>• Describe the layered structure of the Earth<br>• Explain why the crust floats on the magma | **Experiment 4.2**<br>*Cooling and layers*<br>Students investigate the changing density of cooling substances and relate them to the formation of the structure of the Earth.<br><br>**Challenge 4.2**<br>*Modelling the parts of the Earth*<br>Students use a hard-boiled egg to represent the curst, mantle and core of the Earth.<br><br>**The Earth's layers**<br>Students can compare two views of defining the layers of the Earth's structure with the Earth Guide animation – the response to stress and the composition. | **Oxford Science 9 Victorian Curriculum resources**<br>• Check your learning, page 75<br>• Experiment 4.2, page 171<br>• Challenge 4.2, page 172<br><br>**Additional resources**<br>Earth Guide Online Classroom – Earth's layers:<br>http://earthguide.ucsd.edu/eoc/teachers/t_tectonics/p_layers.html |
| **4.3 Boundaries between the tectonic plates can be converging, diverging or transforming**<br><br>**(pages 76–79)** | *Science Understanding*<br>VCSSU127<br><br>*Science as a Human Endeavour*<br>VCSSU114<br>VCSSU116<br><br>*Science Inquiry Skills*<br>VCSIS135<br>VCSIS139<br>VCSIS140 | By the end of this unit, students should be able to:<br>• Define transform boundary, fault, converging boundary, subduction, ocean trench, diverging boundary, rift valley and mid-ocean ridge<br>• Describe the interactions between plates that occur at transform, converging and diverging boundaries<br>• Relate each of the types of boundaries with characteristic land formations | **Challenge 4.3**<br>*Modelling plates*<br>Students model plate interactions with play dough.<br><br>**Subduction**<br>Students can view an annotated animation of a subduction zone and its relationships to volcanic activity and mid-ocean trenches at the Earth Guide site.<br><br>**Comparing boundaries**<br>Students can consolidate their understanding of the processes and characteristic land formations that occur at divergent, convergent and transform boundaries at the Dynamic Earth page. Students can then test their knowledge by playing the Plate Interactions Challenge. | **Oxford Science 9 Victorian Curriculum resources**<br>• Check your learning, page 79<br>• Challenge 4.3, page 172<br><br>**Additional resources**<br>Annenberg Learner – Slip, slide and collide:<br>http://www.learner.org/interactives/dynamicearth/slip.html<br><br>Earth Guide Online Classroom – Subduction:<br>http://earthguide.ucsd.edu/eoc/teachers/t_tectonics/p_subduction.html |

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| **4.4 tectonic plates can be constructive or destructive**<br><br>**(pages 80–83)** | *Science Understanding*<br>VCSSU127<br><br>*Science as a Human Endeavour*<br>VCSSU116<br><br>*Science Inquiry Skills*<br>VCSIS135<br>VCSIS139<br>VCSIS140 | By the end of this unit, students should be able to:<br>• Define tsunami<br>• Describe how the Hawaiian Islands may have formed from a hotspot<br>• Provide examples of natural events that occur as a result of plate interactions<br>• Explain why Australia experiences earthquakes<br>• Relate constructive and destructive boundaries with divergent and convergent boundaries respectively | **Challenge 4.4**<br>*Volcanic bubbles*<br>Students use chalk and vinegar to model the formation of volcanic rock, and lemonade to model the relationship between pressure and bubble size.<br><br>**Convection and the hot spot**<br>Students can investigate how convection currents in the mantle drive tectonic movement and two possible reasons for the formation of the Hawaiian Islands in the simulation at the Earth Guide Online Classroom. | **Oxford Science 9 Victorian Curriculum resources**<br>• Check your learning, page 83<br>• Challenge 4.4, page 173<br><br>**Additional resources**<br>Earth Guide Online Classroom – Convection:<br>http://earthguide.ucsd.edu/eoc/teachers/t_tectonics/p_convection2.html |
| **4.5 What will the Earth look like in the future?**<br><br>**(pages 84–85)** | *Science Understanding*<br>VCSSU127<br><br>*Science as a Human Endeavour*<br>VCSSU114<br>VCSSU115<br><br>*Science Inquiry Skills*<br>VCSIS140 | By the end of this unit, students should be able to:<br>• Define<br>• Describe the directions of and likely collisions between the main continental plates<br>• Provide examples of some technologies that enable plate tectonics to be observed and predicted | **Another supercontinent?**<br>Students can use cutouts of the continental plates and, using the current directions of movement, construct a plausible future supercontinent.<br><br>**Earth of the past**<br>Students can see the likely progression of plate tectonics from 600 million years before present to the present day arrangement of continental plates using the Plate Reconstruction animation. | **Oxford Science 9 Victorian Curriculum resources**<br>• Extend your understanding, page 85<br><br>**Additional resources**<br>Earth Guide Online Classroom – Plate reconstruction:<br>http://earthguide.ucsd.edu/eoc/teachers/t_tectonics/p_plate_reconstruction_blakey.html |

| | | | | |
|---|---|---|---|---|
| **4 Review**<br><br>**(pages 86–88)** | *Science Understanding*<br>VCSSU127<br><br>*Science as a Human Endeavour*<br>VCSSU114<br><br>*Science Inquiry Skills*<br>VCSIS140 | By the end of this unit, students should be able to:<br>• Define all Key Words listed on page 88<br>• Explain global patterns of geological activity and continental movement with the theory of plate tectonics<br>• Identify areas of personal strengths and weaknesses in their knowledge and understanding of the topic | **Revision activities**<br>• Students could play celebrity heads with the Key Words list<br>• Students can make dominoes with Key Words on one end and definitions/diagrams/examples on the other end<br>• Students can create mind maps, Venn diagrams or other graphic organisers to summarise the key concepts of this chapter<br>• 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 Victorian Curriculum resources**<br>• Review questions, pages 86–87<br>• Research topics, page 87<br>• Key Words list, page 88 |



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# Chapter 4: Chemical reactions

Pages 89–114

## 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 Mass is conserved in a chemical reaction

Pages 90–91

### Additional activity: Representing chemicals

This activity is designed to both revise the terminology used in earlier chapters and introduce the idea that chemicals exist in three-dimensional space. The revision of the terms 'molecule', 'compound' and 'element' is an opportunity to introduce the chemical formulas of common molecules such as oxygen ($O_2$), nitrogen ($N_2$), hydrogen ($H_2$), and common compounds such as carbon dioxide ($CO_2$), hydrochloric acid (HCl), water ($H_2O$) and the metal salt sodium chloride (NaCl).

### Additional activity: Kinaesthetic modelling

The importance of an atom occupying a three-dimensional space (from the previous chapter) needs to be reinforced and extended to include molecules. Creating models, using different-coloured modelling clay to represent each element, will aid this. More advanced students can relate the size of an atom to its position in the periodic table.

Students could create oxygen, methane and carbon dioxide.

### Teaching tip: KWL of chemical reactions

Most students will be more familiar with individual elements than with what happens when they react together. For this topic, students could construct a KWL chart (Know – what they already know; W – what they want to know; and, at the end of the section, L – new information they have learnt). This strategy then also becomes a summary activity and helps reflection on the effectiveness of teaching and student learning.

Introduce the students to as many examples of chemical reactions as you can.

### Additional activity: Components of compounds

Students can investigate the components of common compounds and compare the properties of the components to the compound itself. For example, sodium chloride is safe to eat, but it is comprised of sodium (a metal that reacts violently with water) and chlorine (a poisonous gas). Other good examples are water ($H_2O$), hydrochloric acid (HCl) and silver nitrate ($AgNO_3$). Students should be able to see that the properties of a compound can differ wildly from the properties of the elements that form the compound.

## Going further

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

### Video: Beautiful chemistry

This website has a number of wonderful close-up videos of chemical reactions taking place.


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## Teacher notes

# 4.2 The rearrangement of atoms in a chemical reaction can be shown using a balanced equation

Pages 92–93

### Introducing the topic

This section discusses how chemical reactions can be described through observations, word equations or symbols. Students will also be introduced to balancing chemical equations, an important skill in science.

### Teaching tip: Balancing chemical equations

A systematic approach to balancing equations is useful. Spending time checking the formulas of the reactants and products will prevent equations that are impossible to balance later. Many reactions at this stage include using metals; students may need to be reminded that metals can be written as a single atom; for example, magnesium can be Mg, sodium can be Na.

### Additional activity: Kinaesthetic modelling

Write and draw three copies of the reactant molecule ($NaN_3$) and product molecules (Na and $N_2$) on individual pieces of card. Start with one card for each molecule, representing the chemical equation. Students can add the number of atoms on each side of the equation. If another atom is needed, a whole card/molecule must be added and the number of atoms tallied again.

This can be repeated with other chemical reactions:

- $2Cu + S \rightarrow Cu_2S$
- $C_3H_6O + 4O_2 \rightarrow 3CO_2 + 3H_2O$
- $2C_2H_6 + 7\ O_2 \rightarrow 6\ H_2O + 4\ CO_2$

### Additional activity: Hindenburg

Students can work in groups of five to research the *Hindenburg* disaster and create commentary to accompany the newsreel footage on the Internet. Each member of the group can perform a role, including:

- news reader: giving the date and briefly introducing what happened
- on-the-scene reporter: describing the aftermath and how the fire-fighters of the day coped
- witness: describing in detail the events that occurred
- expert scientist: explaining what happened and how it may have happened
- aviation expert: describing the future of air travel following the disaster.


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### Additional activity: Balancing equations

To give students additional practise at balancing chemical equations, you could ask students to balance given reactants and products of acid-rain reactions. For example, sulfur dioxide, oxygen gas and water will combine to form sulfuric acid. ($2SO_2 + O_2 + 2H_2O \rightarrow 2H_2SO_4$).

## Going further

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

### Fundamental chemical concepts

This BBC Bitesize website instructs students on how to balance chemical equations and incorporates both word and symbol equations.


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## Teacher notes

# 4.3 Synthesis and decomposition reactions can be represented by equations

Pages 94–95

### 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

# 4.4 Acid reactions depend on strength and concentration

Pages 96–97

### 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

# 4.5 The solubility rules predict the formation of precipitates

Pages 98–99

### 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

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

Pages 100–101

## 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 + $O_2 \rightarrow H_2O + CO_2$ + energy

metal + $O_2 \rightarrow$ 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

# 4.7 Polymers are long chains of monomers

Pages 102–103

## 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

# 4.8 Temperature, concentration, surface area and stirring affect reaction rate

Pages 104–107

## 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

# 4.9 Catalysts increase the rate of a reaction

Pages 108–109

### 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

# 4.10 Green chemistry reduces the impact of chemicals on the environment

Pages 110–111

### 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; chemical reactions may be represented by balanced chemical equations VCSSU125<br>• Chemical reactions, including combustion and the reactions of acids, are important in both non-living and living systems and involve energy transfer VCSSU126<br>• Scientific understanding, including models and theories, are contestable and are refined over time through a process of review by the scientific community VCSSU114<br>• Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries VCSSU115<br>• The values and needs of contemporary society can influence the focus of scientific research VCSSU116<br>• Formulate questions or hypotheses that can be investigated scientifically, including identification of independent, dependent and controlled variables VCSIS134<br>• Independently plan, select and use appropriate investigation types, including fieldwork and laboratory experimentation, to collect reliable data, assess risk and address ethical issues associated with these investigation types VCSIS135<br>• Select and use appropriate equipment and technologies to systematically collect and record accurate and reliable data, and use repeat trials to improve accuracy, precision and reliability VCSIS136<br>• Construct and use a range of representations, including graphs, keys, models and formulas, to record and summarise data from students' own investigations and secondary sources, to represent qualitative and quantitative patterns or relationships, and distinguish between discrete and continuous data VCSIS137<br>• Analyse patterns and trends in data, including describing relationships between variables, identifying inconsistencies in data and sources of uncertainty, and drawing conclusions that are consistent with evidence VCSIS138<br>• Use knowledge of scientific concepts to evaluate investigation conclusions, including assessing the approaches used to solve problems, critically analysing the validity of information obtained from primary and secondary sources, suggesting possible alternative explanations and describing specific ways to improve the quality of data VCSIS139 |


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| • Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations VCSIS140 |
| **Achievement standards** |
| Students use atomic symbols and balanced chemical equations to summarise chemical reactions, including neutralisation and combustion. They explain how different factors influence the rate of 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 VCSSU125<br><br>Science Inquiry Skills VCSIS134 VCSIS135 VCSIS138 VCSIS139 VCSIS140 | By the end of this unit, students should be able to:<br>• recognise the difference between a synthesis and decomposition reaction<br>• explain that heat and electricity and sometimes needed in decomposition reactions<br>• write, balance and assign states to simple synthesis and decomposition reaction equations. | **What if?**<br>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.<br><br>These experiments are excellent demos if time within the classroom is limited.<br><br>**Experiment 4.1A**<br>Direct Synthesis with a POP.<br>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:<br>Acid + Metal → Salt + Hydrogen Gas<br>OR<br>A single displacement reaction<br>NB: technically this is both synthesis and decomposition as the acid decomposes to synthesise the salt and gas.<br><br>**Experiment 4.1B**<br>Decomposing a Carbonate:<br>Students use heat to decompose | **Oxford Science 10 resources**<br>• What if? Page 89<br>• Check your learning, page 91<br>• Experiment 4.1A, page 201<br>• Experiment 4.1B, page 202<br>• Experiment 4.1C, page 203<br><br>**Additional resources**<br>Phet balancing chemical equations simulation provides a visual animation and simulation to demonstrate the law of conservation of mass.<br>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).<br><br>**Experiment 4.1C**<br>Electrolysis:<br>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.<br>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<br>(pages 92–93) | Science Understanding<br>VCSSU125<br><br>Science Inquiry Skills<br>VCSIS135<br>VCSIS137<br>ACSIS138<br>ACSIS139<br>VCSIS140 | By the end of this unit, students should be able to:<br>• determine the difference between an acid and a base including key features and properties<br>• identify a neutralisation reactions and explain why it is named this way<br>• write, balance and assign states to neutralisation reactions<br>• identify acid reactions and their products<br>• write, balance and assign states to reactions of acids with:<br>–metal oxides<br>–metal carbonates<br>• explain the difference between acid strength and concentration. | **Experiment 4.2**<br>Acid Titrations:<br>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.<br>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.<br><br>Note: this will help students to answer question 5 on page 93. | **Oxford Science 10 resources**<br>• Check your learning, page 93<br>• Experiment 4.2, page 204<br><br>**Additional resources**<br>Phet Acid Base simulation provides a visual animation and simulation to allow students to visualise strong vs weak acids and bases:<br>https://phet.colorado.edu/en/simulation/acid-base-solutions<br><br>And concentration:<br>https://phet.colorado.edu/en/simulation/concentration |
| 4.3 The solubility rules predict the formation of precipitates<br>(pages 94–95) | Science Understanding<br>VCSSU125<br><br>Science Inquiry Skills<br>VCSIS134<br>VCSIS135<br>ACSIS138<br>ACSIS139<br>VCSIS140 | By the end of this unit, students should be able to:<br>• identify precipitation reactions and explain why it is named this way<br>• define the state 'aqueous' as a chemical which is dissolved in water<br>• write, balance and assign states to precipitation reactions<br>• determine whether a chemical is solid (s) or aqueous (aq) based on solubility rules | **Experiment 4.3**<br>Precipitation reactions:<br>Students determine which compounds form precipitates and write equations for the reactions occurring.<br><br>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**<br>• Check your learning, page 95<br>• Experiment 4.3, page 205 |


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| | | • explain the importance of precipitation reactions. | also gives them practice in developing chemical formulae, balancing and assigning states using the solubility table.<br><br>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<br>(pages 96–97) | Science Understanding<br>VCSSU125<br><br>Science Inquiry Skills<br>VCSIS135<br>VCSIS137<br>VCSIS139<br>VCSIS140 | By the end of this unit, students should be able to:<br>• define the terms oxidation, combustion and hydrocarbon<br>• write, balance and assign states to oxidation reactions with:<br>–metals<br>–non-metals<br>• write, balance and assign states to combustion reactions with hydrocarbons<br>• explain the effect of limiting the amount of oxygen in hydrocarbon combustion reactions<br>• identify common chemical fuels and their relation to hydrocarbons<br>• explain “carbon economy” making reference to real world science. | **Experiment 4.4**<br>Combustion of wire wool:<br>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**<br>• Check your learning, page 97<br>• Experiment 4.4, page 206 |


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| 4.5 Polymers are long chains of monomers<br>(pages 98–99) | Science Understanding<br>VCSSU125<br><br>Science Inquiry Skills<br>VCSIS135<br>VCSIS137<br>ACSIS139<br>VCSIS140 | By the end of this unit, students should be able to:<br>• define the terms monomer, polymer, cross-linked, thermosetting and thermoplastic<br>• explain the properties of polymers based on their structures<br>• determine whether polymers are thermoplastic or thermosetting based on their properties and determine where this knowledge may be useful around the home/ real world<br>• explain the formation of polymers and relate the name of a polymer to the name of its monomer units. | **Experiment 4.5**<br>Polymerisation of casein:<br>Students use milk and ethanoic acid to form casein plastic: polymers of casein monomers. Casein is a protein found in mammalian milk products.<br><br>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.<br><br>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**<br>• Check your learning, page 99<br>• Experiment 4.5, page 207<br><br>**Additional resources**<br>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.<br>https://www.youtube.com/watch?v=rHxxLYzJ8Sw |
| 4.6 Temperature, concentration, surface area and stirring affect reaction rate<br>(pages 100–103) | Science Understanding<br>VCSSU125<br>VCSSU126<br><br>Science Inquiry Skills<br>VCSIS135 | By the end of this unit, students should be able to:<br>• define collision theory and identify how this relates to the rate of a chemical reaction<br>• identify the key elements required for molecules to collide and result in a successful reaction which forms products | **Experiment 4.6A**<br>The effect of temperature on reaction rate:<br>Students investigate the effect of temperature on reaction rate.<br><br>**Experiment 4.6B**<br>Factors affecting reaction rate:<br>Students investigate the rates of a | **Oxford Science 10 resources**<br>• Check your learning, page 103<br>• Experiment 4.6A, page 208<br>• Experiment 4.6B, page 209<br><br>**Additional resources**<br>YouTube Video<br>"How to speed up chemical reactions (and get a date) – Aaron Sams" |


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| | ACSIS139<br>VCSIS140 | • explain how to increase the rate of a chemical reaction using collision theory for:<br>–surface area<br>–concentration<br>–temperature<br>–stirring. | reaction between hydrochloric acid and calcium carbonate. This experiment determines the effect of surface area on the rate of a chemical reaction.<br><br>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<br><br>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<br>https://phet.colorado.edu/en/simulation/legacy/reactions-and-rates |
| 4.7 Catalysts increase the rate of a reaction<br>(pages 104–105) | Science Understanding<br>VCSSU125<br>VCSSU126<br><br>Science Inquiry Skills<br>VCSIS134<br>VCSIS135<br>VCSIS136<br>VCSIS137<br>ACSIS138<br>ACSIS139<br>VCSIS140 | By the end of this unit, students should be able to:<br>• define what a catalyst is and how it can increase the rate of a chemical reaction<br>• explain the two types of catalysts and give examples<br>• explain real world examples of reactions which require catalysts and determine whether they are beneficial to society. | **Experiment 4.7**<br>Using a catalyst:<br>Students investigate the effect of adding a catalyst to a reaction. The reaction used in this experiment is the decomposition of hydrogen peroxide:<br>$2\ H_2O_2\,(aq) \rightarrow 2\ H_2O\ (l) + O_2\,(g)$<br><br>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**<br>• Check your learning, page 105<br>• Experiment 4.7, page 210<br><br>**Additional resources**<br>YouTube Video<br>Elephant's Toothpaste Geyser With Science Bob on Jimmy Kimmel<br>https://www.youtube.com/watch?v=p1eG2y2mn54<br>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<br>(pages 106–107) | Science Understanding<br>VCSSU125<br><br>Science as a Human Endeavour<br>VCSSU115<br>VCSSU116<br><br>Science Inquiry Skills<br>VCSIS140 | By the end of this unit, students should be able to:<br>• define what green chemistry is and why it is beneficial to the environment/ society<br>• explain the negative cost of:<br>–low-impact chemicals<br>–pesticides and herbicides<br>–heavy metals<br>–solvent-based paints and why they are no longer used<br>• determine how people (particularly themselves), as citizens, can utilise the principals of green chemistry to reduce their carbon footprint. | **Activity:**<br>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**<br>• Extend your understanding, page 107 |
| 4 Review<br>(pages 108–109) | Science Understanding<br>VCSSU125<br>VCSSU126<br><br>Science Inquiry Skills<br>VCSIS140 | By the end of this unit, students should be able to:<br>• define all Key words listed on page 110<br>• identify, write, balance and assign states to chemical reactions:<br>–synthesis<br>–decomposition<br>–acid<br>–precipitation<br>–combustion<br>–polymers<br>• explain chemical rates of reaction and the factors which affect them<br>• explain how catalysts can affect a chemical rate of reaction | **Revision activities**<br>• Students could play celebrity heads with the Key words list<br>• Students can make dominoes with Key words on one end and definitions/diagrams/examples on the other end<br>• Students can create mind maps, Venn diagrams or other graphic organisers to summarise the key concepts of this chapter<br>• 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 10 resources**<br>• Review questions, pages 108–109<br>• Research topics, page 109<br>• Key words list, page 110 |


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| | | • define green chemistry and explain how this benefits society<br>• identify areas of personal strengths and weaknesses in their knowledge and understanding of the topic. | | |


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