Module: Carbon
Unit outline for teachers
years 3 to 4

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INQuIRY

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Australian Curriculum covered in this unit:

INQuIRY

Learning area		General capabilities		Cross-curriculum priorities	
✓	English	✓	Literacy		Aboriginal and Torres Strait Islander histories and cultures
✓	Mathematics	✓	Numeracy	✓	Asia and Australia's engagement with Asia
✓	Science	✓	Information and communication technology (ITC) competence	✓	Sustainability
	History	✓	Critical and creative thinking		
	Geography	✓	Social and personal competence		
		✓	Ethical behaviour		
		✓	Intercultural understanding		

Carbon clues

A unit for Years 3 to 4

Unit outline for teachers

Introduction

Carbon is all around us and available to us in many different forms, yet we can't see it and often we don't even know it's there. Whether it's a tree, a bird or the ground that we're walking on, it all consists of carbon. Even indoors, many of the things we use every day – wooden tables, plastic chairs and most of our food – are mostly carbon. The ***Carbon clues*** unit is an ideal way to investigate the science of carbon and improve the scientific literacy of students in the classroom in a detective story setting. It provides opportunities for students to investigate their understanding of carbon while they sift through the clues and through immersion and discussion, arrive at their own considered opinion about the implications of using carbon in our journey towards living more sustainably.

*'The **Carbon clues** unit is an ideal way to investigate the science of carbon and improve the scientific literacy of students in the classroom in a detective story setting.'*

Units at a glance – INQuIRY teaching and learning model

The WithOnePlanet **INQuIRY** teaching and learning model provides problem and challenge-based activities, designed to build sequential and experiential learning, practical skills and actions, critical thinking, knowledge, and awareness about the impacts of climate change on plants, people and place in our region.

Inquiry model	Lesson sequence	At a glance
 INQuIRY Introduce	**Lesson 1** **Carbon confidential** Students contribute their knowledge about forms of carbon and where it can be found on the Earth.	To capture students' interest and find out what they think they know about carbon as a substance and a component of living and non-living things on the Earth.
 INQuIRY Question	**Lesson 2** **Making inquiries about carbon** Students develop a class essential question about carbon.	To elicit students' questions about carbon as a substance and a component of living and non-living things. To develop a class essential question about carbon and its effects on the environment that students can investigate.
 INQuIRY Investigate	**Lesson 3** **Carbon in disguise** Through fieldwork activities, students investigate the different forms of carbon and some common carbon compounds.	To provide students with hands-on, shared experiences of carbon as a substance, the different forms that carbon can take in the environment and how those forms can be used according to their properties.
	Lesson 4 **Searching for carbon** Through fieldwork activities, students investigate carbon in living things, carbon in the earth and how carbon can be used to produce heat energy.	To provide students with hands-on, investigation experiences of: > how living things take up and use carbon from the environment and release it back into the environment > how natural and man-made processes affect carbon in the earth > the ways that humans can manipulate carbon to produce energy, including heat.
	Lesson 5 **Carbon hides in the air** Students investigate carbon in the atmosphere, how it contributes to the enhanced greenhouse effect and the consequences for life on Earth.	To provide students with hands-on, investigation experiences of: > the connection between the carbon in the air, the enhanced greenhouse effect and Earth's temperature.

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Inquiry model	Lesson sequence	At a glance
INQuIRY Investigate	**Lesson 6** **Tracking carbon's footprints** Students calculate and analyse their own carbon footprints and ways they can reduce them.	To support students to: > calculate their own carbon footprints using information about their own and their families' activities > understand the consequences of the size of their footprints for themselves and their Asia-Pacific neighbours > think of ways to reduce their footprints and how this affects their own lives and the lives of others.
	Lesson 7 **Capture that carbon!** Students review their progress with their essential question and determine if it has been answered.	To provide students with an opportunity to reflect on their progress with their essential question and determine whether or not it has been fully answered. To support students to answer essential question(s) developed by the class.
INQuIRY Review	**Lesson 8** **Comical carbon** Students review their understanding of the unit.	To provide opportunities for students to represent what they know about carbon and to reflect on their learning during the unit.
INQuIRY Your future	**Lesson 9** **Deciding carbon's future** Students decide on where to go next on their own carbon learning journey.	To provide opportunities for students to take their learning about carbon into a new cycle of inquiry in their own preferred direction.

WithOnePlanet Big questions about big ideas

The WithOnePlanet curriculum seeks to engage students in the big idea of carbon and its effects on their immediate environment and that of their neighbours in the Asia Pacific region. The WithOnePlanet – *Carbon curriculum* is based on 5 big questions. These questions can be explored at all levels from Foundation to Year 10, with ever increasing complexity as students move through each unit.

The table below outlines these big questions and provides specific detail about how these ideas can be tackled in Years 3 and 4.

Big Ideas	What is carbon?	What is the carbon cycle?	What is climate change and what role does carbon play in it?	What is my carbon footprint and how can I reduce it?	What can be done to mitigate climate change on a regional scale?
Big ideas	At its core, carbon is a chemical element. Its physical and chemical properties make it the most essential element for life on Earth, and possibly the most versatile element too.	Carbon is essential for life and can be found in all Earth's spheres. The sphere of living organisms (biosphere), of rock and crust (lithosphere), of waters (hydrosphere) and gases (atmosphere). There are many processes that allow carbon to be cycled through these spheres.	Carbon dioxide is a greenhouse gas. When carbon leaves the biosphere and lithosphere and enters the atmosphere and hydrosphere, it enhances the greenhouse effect. This is when the impacts of climate change become visible.	Every living thing is made of carbon and, to survive and thrive, uses carbon in its various forms every day. But humans have the capacity to determine how much carbon they use and to implement changes to reduce it.	The carbon emissions from everyday activities of Australians not only have an impact on our own carbon footprints, but can have significant effects on others in our local region. Furthermore, as Australians, we can not only influence our own carbon footprints, but, through positive actions, can have a positive impact on the lives of our neighbours.
Years 3 to 4	Pure carbon is a chemical that exists naturally in the environment in a range of different forms; these forms have different properties.	Living things take and use carbon from the environment and return it to the environment in a variety of natural and man-made processes.	The greenhouse effect is a natural and essential process for life on Earth. The enhanced greenhouse effect causes the Earth to heat up as a result of too much carbon being present in the atmosphere.	I can calculate my carbon footprint, using digital technologies, by providing information about the lifestyle of myself and my family. My carbon footprint can tell me how many planet Earths would be needed if everyone's lifestyle was like mine.	My actions and decisions can have an impact on the livelihoods and lifestyles of people in other places in the Asia-Pacific region.

Alignment with the Australian Curriculum: Science

This *Carbon clues* unit embeds all three strands of the Australian Curriculum: Science. The table below lists sub-strands and their content for Years 3 and 4. This unit is designed to be taught in conjunction with other units at Years 3 and 4 to cover the full range of the Australian Curriculum: Science content.

The table below outlines the sub-strands and their content aligned to lessons.

Strand	Sub-strand	Year level	Code	Years 3 to 4 content descriptions	Lesson
Science understanding	Biological sciences	3	ACSSU044	Living things can be grouped on the basis of observable features and can be distinguished from non-living things.	1, 4
		4	ACSSU072	Living things have life cycles.	2, 3, 4, 5, 6
			ACSSU073	Living things, including plants and animals, depend on each other and the environment to survive.	2, 3, 4, 5, 6
	Chemical sciences	3	ACSSU046	A change of state between solid and liquid can be caused by adding or removing heat.	1, 2, 3, 4, 5, 6
		4	ACSSU074	Natural and processed materials have a range of physical properties; these properties can influence their use.	1, 2, 3, 4, 5, 6
	Earth and space sciences	3	ACSSU048	Earth's rotation on its axis causes regular changes, including night and day.	1, 2, 3, 4, 5, 6
		4	ACSSU075	Earth's surface changes over time as a result of natural processes and human activity.	1, 2, 3, 4, 5, 6
	Physical sciences	3	ACSSU049	Heat can be produced in many ways and can move from one object to another.	4, 5
		4	ACSSU076	Forces can be exerted by one object on another through direct contact or from a distance.	4, 5
Science as a human endeavour	Nature and development of science	3 & 4	ACSHE050	Science involves making predictions and describing patterns and relationships.	1, 2, 3, 4, 5, 6
	Use and influence of science	3 & 4	ACSHE051	Science knowledge helps people to understand the effect of their actions.	3, 4, 5, 6, 7, 8
Science inquiry skills	Questioning and predicting	3 & 4	ACSIS053	With guidance, students can identify questions in familiar contexts that can be investigated scientifically and predict what might happen based on prior knowledge.	1, 2, 7, 8
	Planning and conducting	3 & 4	ACSIS054	Students can suggest ways to plan and conduct investigations to find answers to questions.	4, 5, 6, 7, 9
			ACSIS055	Students can safely use appropriate materials, tools or equipment to make and record observations, using formal measurements and digital technologies as appropriate.	3, 4, 5, 6
	Processing and analysing data and information	3 & 4	ACSIS057	Students can use a range of methods including tables and simple column graphs to represent data and to identify patterns and trends.	1, 3, 4, 5, 6
			ACSIS215	Students can compare results with predictions, suggesting possible reasons for findings.	4, 5, 6, 7

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Strand	Sub-strand	Year level	Code	Years 3 to 4 content descriptions	Lesson
	Evaluating	3 & 4	ACSIS058	Students can reflect on the investigation, including whether a test was fair or not.	?
	Communicating	3 & 4	ACSIS060	Students can represent and communicate ideas and findings in a variety of ways, such as diagrams, physical representations and simple reports.	1, 2, 3, 4, 5, 6, 7, 8, 9

Alignment with Australian Curriculum: Science – Overarching ideas

Overarching idea	Incorporation in *Carbon clues*
Patterns, order and organisation	Students compare similarities and differences and identify patterns in: > living things and non-living things > burning of all carbon-based matter > carbon footprints from different individuals and cultures. Students organise their ideas and understanding in: > the analysis of first- and second-hand data > developing essential questions about carbon > analysing the carbon stored in living and non-living structures > designing and planning a postcard that shows how they connect to their home.
Form and function	Students explore how different forms – both living and non-living – all contain carbon. They link the storage of carbon in materials to their ability to release energy in the form of heat, and carbon dioxide.
Stability and change	Students discuss how: > burning of carbon-based substances can release the energy from carbon and increase carbon dioxide emissions, leading to the enhanced greenhouse effect > the needs and desires of people and the planet can be similar, yet the ability to meet those needs and desires can be vastly different > humanity's demand for energy can affect the stability of different forms of carbon, and change one form into another.
Scale and measurement	Students measure and compare the carbon footprint to those of people living in different countries with different lifestyles. Students compare their affluence to that of others in developing countries.
Matter and energy	Students investigate their own carbon content of living and non-living matter and how energy can be released from carbon-based matter through burning.
Systems	Students investigate large-scale Earth systems including the enhanced greenhouse effect and its impact on global temperatures. They identify inputs and outputs necessary for the maintenance of stability in plant and animal systems.

Alignment with Australian Curriculum: Science – Curriculum focus

The Australian Curriculum: Science is described by year level, but provides advice across four year groupings on the nature of learners. Each year grouping has a relevant curriculum focus.

Curriculum focus Years 3 to 4	Incorporation in *Carbon clues*
Recognising questions that can be investigated scientifically and investigating them	This *Carbon* unit is primarily structured around questions, and big scientific questions in particular. With guidance and support, students are encouraged to develop group-based scientific questions and are then provided with structured and modelled pathways through which to investigate possible answers and solutions.

Alignment with Australian Curriculum: Science – Achievement standards

The achievement standards of the Australian Curriculum: Science indicates the quality of learning that students typically demonstrate by a particular point in their schooling, for example, at the end of a year level. These standards will be reviewed regularly by ACARA and are available on the ACARA website.

By the end of this unit, teachers will be able to make evidence-based judgments on whether the students are achieving below, at or above the Australian Curriculum: Science Years 3 and 4 achievement standards.

Alignment with Australian Curriculum: English

This *Carbon clues* unit also embeds a number of content descriptions from the Literacy strand of the Australian Curriculum: English. The table below lists content descriptions for Years 3 and 4 that are covered in this unit.

Strand	Sub-strand	Year level	Code	Years 3 to 4 content descriptions	Lesson
Literature	Creating literature	3	ACELT1601	Create imaginative texts based on characters, settings and events from students' own and other cultures using visual features, for example perspective, distance and angle.	8
			ACELT1791	Create texts that adopt language features and patterns encountered in literary texts, for example characterisation, rhyme, rhythm, mood, music, sound effects and dialogue.	8
		4	ACELT1607	Create literary texts that explore students' own experiences and imagining.	8
			ACELT1794	Create literary texts by developing storylines, characters and settings.	8
			ACELY1676	Listen to and contribute to conversations and discussions to share information and ideas and negotiate in collaborative situations.	1, 2, 6, 7, 8, 9

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Strand	Sub-strand	Year level	Code	Years 3 to 4 content descriptions	Lesson
Literacy	Interacting with others	3	ACELY1792	Use interaction skills, including active listening behaviours, and communicate in a clear, coherent manner using a variety of everyday and learned vocabulary and appropriate tone, pace, pitch and volume.	1, 2, 6, 7, 8, 9
			ACEL1677	Plan and deliver short presentations, providing some key details in logical sequence.	8
		4	ACELY1688	Use interaction skills such as acknowledging another's point of view and linking students' response to the topic, using familiar and new vocabulary and a range of vocal effects such as tone, pace, pitch and volume to speak clearly and coherently.	8
			ACELY1689	Plan, rehearse and deliver presentations incorporating learned content and taking into account the particular purposes and audiences.	8
	Interpreting, analysing, evaluating	3	ACELY1678	Identify the audience and purpose of imaginative, informative and persuasive texts.	6, 8
			ACELY1712	Select, navigate and read texts for a range of purposes, applying appropriate text processing strategies and interpreting structural features, for example table of contents, glossary, chapters, headings and subheadings.	1, 6, 8
		4	ACELY1713	Use comprehension strategies to interpret and analyse information and ideas, comparing content from a variety of textual sources including media and digital texts.	1, 5, 6, 8
			ACELY1690	Identify characteristic features used in imaginative, informative and persuasive texts to meet the purpose of the text.	6, 8
			ACELY1692	Use comprehension strategies to build literal and inferred meaning to expand content knowledge, integrating and linking ideas and analysing and evaluating texts.	6, 8

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Literacy	Creating texts	3	ACELY1682	Plan, draft and publish imaginative, informative and persuasive texts demonstrating increasing control over text structures and language features and selecting print and multimodal elements appropriate to the audience and purpose.	6, 8
			ACELY1683	Reread and edit texts for meaning, appropriate structure, grammatical choices and punctuation.	6, 8
			ACELY1685	Use software including word processing programs with growing speed and efficiency to construct and edit texts featuring visual, print and audio elements.	8
		4	ACELY1694	Plan, draft and publish imaginative, informative and persuasive texts containing key information and supporting details for a widening range of audiences, demonstrating increasing control over text structures and language features.	6, 8
			ACELY1695	Reread and edit for meaning by adding, deleting or moving words or word groups to improve content and structure.	6, 8
			ACELY1697	Use a range of software including word processing programs to construct, edit and publish written text, and select, edit and place visual, print and audio elements.	8

Alignment with Australian Curriculum: General capabilities

The skills, behaviours and attributes that students need to succeed in life and work in the 21st century have been identified in the Australian Curriculum as General capabilities. There are seven general capabilities and they are embedded throughout the Science curriculum.

For further information go to: ACARA 2012, *General Capabilities in the Australian Curriculum*, viewed 20 December 2013, <http://www.australiancurriculum.edu.au/GeneralCapabilities/Overview/General-capabilities-in-the-Australian-Curriculum>.

For examples of our unit-specific General capabilities information see the table below.

General capabilities	Australian curriculum description	*Carbon clues* example
Literacy	By learning the literacy of science, students understand that language varies according to context and they increase their ability to use language flexibly. Scientific vocabulary is often technical and includes specific terms for concepts and features of the world, as well as terms that encapsulate an entire process in a single word, such as 'photosynthesis'. Students learn to understand that much scientific information is presented in the form of diagrams, flow charts, tables and graphs.	The literacy focuses are: > tables > graphs > websites > pictures, drawings and diagrams > flowcharts > graphic organisers > videos > infographics

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Numeracy	Many elements of numeracy are evident in the Science Curriculum, particularly in science inquiry skills. These include practical measurement and the collection, representation and interpretation of data from investigations. Students are introduced to measurement, first using informal units then formal units. Later they consider issues of uncertainty and reliability in measurement. As students progress, they collect both qualitative and quantitative data, which is analysed and represented in graphical forms. Students learn data analysis skills, including identifying trends and patterns from numerical data and graphs. In later years, numeracy demands include the statistical analysis of data, including issues relating to accuracy, and linear mathematical relationships to calculate and predict values.	Students: > collect and analyse data in infographics and tables > analyse, represent and communicate data in drawings, tables, diagrams and flow charts > interpret data in graphs, tables and diagrams.
Information and communication technology (ICT) competence	Students develop ICT capability when they research science concepts and applications, investigate scientific phenomena, and communicate their scientific understandings. In particular, they employ their ICT capability to access information; collect, analyse and represent data; model and interpret concepts and relationships; and communicate science ideas, processes and information. Digital technology can be used to represent scientific phenomena in ways that improve students' understanding of concepts, ideas and information. Digital aids such as animations and simulations provide opportunities to view phenomena and test predictions that cannot be investigated through practical experiments in the classroom and may enhance students' understanding and engagement with science.	Students: > use digital devices to record their ideas, and responses to questions and issues > use online videos, animations, tools and software programs to view, record and analyse information.

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Critical and creative thinking	In the science learning area, critical and creative thinking are embedded in the skills of posing questions, making predictions, speculating, solving problems through investigation, making evidence-based decisions, and analysing and evaluating evidence. Students develop understandings of concepts through active inquiry that involves planning and selecting appropriate information, and evaluating sources of information to formulate conclusions. Creative thinking enables the development of ideas that are new to the individual, and this is intrinsic to the development of scientific understanding. Scientific inquiry promotes critical and creative thinking by encouraging flexibility and open-mindedness as students speculate about their observations of the world. Students' conceptual understanding becomes more sophisticated as they actively acquire an increasingly scientific view of their world.	Students: > formulate, pose and respond to questions for inquiry > consider different ways of thinking about contemporary environmental issues > develop evidence-based opinions about environmental issues.
Personal and social competence	Students develop personal and social capability as they engage in science inquiry, learn how scientific knowledge informs and is applied in their daily lives, and explore how scientific debate provides a means of contributing to their communities. This includes developing skills in communication, initiative taking, goal setting, interacting with others and decision making, and the capacity to work independently and collaboratively. The science learning area enhances personal and social capability by expanding students' capacity to question, solve problems, explore and display curiosity. Students use their scientific knowledge to make informed choices about issues that have an impact on their lives, such as health and nutrition and environmental change, and consider the application of science to meet a range of personal and social needs.	Students: > work collaboratively in teams > participate in discussions > follow directions to work safely > follow detailed instructions when completing practical and written tasks.

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Ethical behaviour	Students develop the capacity to form and make ethical judgments in relation to experimental science, codes of practice, and the use of scientific information and science applications. They explore what integrity means in science, and explore and apply ethical guidelines in their investigations. They consider the implications of their investigations on others, the environment and living organisms. They use scientific information to evaluate claims and to inform ethical decisions about a range of social, environmental and personal issues, for example, land use or the treatment of animals.	Students: > ask questions respecting each other's points of view > consider their rights and responsibilities as a global citizen and an environmental steward.
Intercultural understanding	There are opportunities in the science learning area to develop intercultural understanding. Students learn to appreciate the contribution that diverse cultural perspectives have made to the development, breadth and diversity of science knowledge and applications. Students become aware that the raising of some debates within culturally diverse groups requires cultural sensitivity. They recognise that increasingly scientists work in culturally diverse teams and engage with culturally diverse communities to address issues of international importance.	Students are given opportunities to: > compare their livelihoods with others in other cultures > recognise the value of collaboration with peoples of different cultures in identifying and implementing solutions to global issues.

Alignment with Australian Curriculum: Cross-curriculum priorities

There are three cross-curriculum priorities identified by the Australian Curriculum:

> Aboriginal and Torres Strait Islander histories and cultures.
> Asia and Australia's engagement with Asia.
> Sustainability.

For each cross-curriculum priority, a set of organising ideas reflects the essential knowledge, understandings and skills for the priority. The organising ideas are embedded in the content descriptions and elaborations of each learning area as appropriate.

Aboriginal and Torres Strait Islander histories and cultures

Carbon clues primarily focuses on the Western science way of making evidence-based claims about things required for survival.

Indigenous cultures might have different explanations about the needs for survival, and they might prioritise their relative importance in different ways depending on their culture.

WithOnePlanet recommends working with Indigenous community members to access contextualised, relevant Indigenous perspectives.

Code	Organising ideas	Incorporation in *Carbon clues*
Country/Place		
011	Australia has two distinct Indigenous groups, Aboriginal Peoples and Torres Strait Islander Peoples.	N/A
012	Aboriginal and Torres Strait Islander communities maintain a special connection to and responsibility for Country/Place throughout Australia.	N/A
013	Aboriginal and Torres Strait Islander Peoples have unique belief systems and are spiritually connected to the land, sea, sky and waterways.	N/A
Culture		
014	Aboriginal and Torres Strait Islander societies have many language groups.	N/A
015	Aboriginal and Torres Strait Islander Peoples' ways of life are uniquely expressed through ways of being, knowing, thinking and doing.	N/A
016	Aboriginal and Torres Strait Islander Peoples have lived in Australia for tens of thousands of years and experiences can be viewed through historical, social and political lenses.	N/A
People		
017	The broader Aboriginal and Torres Strait Islander societies encompass a diversity of nations across Australia.	N/A
018	Aboriginal and Torres Strait Islander Peoples have sophisticated family and kinship structures.	N/A
019	Australia acknowledges the significant contributions of Aboriginal and Torres Strait Islander people locally and globally.	N/A

Asia and Australia's engagement with Asia

Asia and Australia's engagement with Asia is a key of the *Carbon* curriculum and is integrated into the curriculum throughout F to10.

The table below outlines the organising ideas for Asia and Australia's engagement with Asia and their content aligned to lessons.

Code	Organising ideas	Incorporation in *Carbon clues*
Asia and its diversity		
011	The peoples and countries of Asia are diverse in ethnic background, traditions, cultures, belief systems and religions.	Students compare their ecological footprints with peoples of other cultures and discuss why they may be similar or different.

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012	Interrelationships between humans and the diverse environments in Asia shape the region and have global implications.	Students discuss the differences and similarities in ecological footprints between different Asian environments.
Achievements and contributions of the peoples of Asia		
013	The peoples and countries of Asia have contributed and continue to contribute to world history and human endeavour.	N/A
Asia-Australia engagement		
015	Collaboration and engagement with the peoples of Asia support effective regional and global citizenship.	Students discuss the merits and value of collaboration and engagement with the peoples of Asia in reducing global and regional greenhouse gas emissions, while improving quality of life, particularly of poorer Asian regions.
016	Australia is part of the Asia region and our histories from ancient times to the present are linked.	Students develop an understanding that the historical and future actions of Australia directly influence the ability of the Asian region to mitigate climate change and improve livelihoods.
017	Australians play a significant role in social, cultural, political and economic developments in the Asia region.	Students develop an understanding that the historical and future actions of Australia directly influence the ability of the Asian region to mitigate climate change and improve livelihoods.
018	Australians of Asian heritage have influenced Australia's history and continue to influence its dynamic culture and society.	

Sustainability

Sustainability is a key component of the *Carbon* curriculum and is integrated into the curriculum throughout F to10. The table below outlines the organising ideas for *Sustainability* and their content aligned to lessons.

Code	Organising ideas	Incorporation in *Carbon clues*
Systems		
011	The biosphere is a dynamic system providing conditions that sustain life on Earth.	Carbon is an integral component of the biosphere and changes in the biosphere can have a direct impact on the movement of carbon and energy throughout the carbon cycle.
012	All life forms, including human life, are connected through ecosystems on which they depend for their well-being and survival.	Carbon moves through ecosystems and this movement can affect the wellbeing and survival of all life forms.
013	Sustainable patterns of living rely on the interdependence of healthy social, economic and ecological systems.	The global nature of greenhouse gas emissions and the consequent effect on climate highlight and reveal the interdependence of social, economic and ecological systems.

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World views		
014	World views that recognise the dependence of living things on healthy ecosystems, and value diversity and social justice, are essential for achieving sustainability.	Evidence and experience-based world views about climate change emphasise the importance of social justice and sustainability for all communities and cultures.
015	World views are formed by experiences at personal, local, national and global levels, and are linked to individual and community actions for sustainability.	Evidence and experience-based world views about climate change emphasise the links between individual and community actions.
Futures		
016	The sustainability of ecological, social and economic systems is achieved through informed individual and community action that values local and global equity and fairness across generations into the future.	Acceptance of individual and community responsibility for climate change encourages ideas about global equity and fairness and emphasises the importance of sustainability for ecological, social and economic systems.
017	Actions for a more sustainable future reflect values of care, respect and responsibility, and require us to explore and understand environments.	Recognition of the need for understanding and action on climate change encourages care, respect and responsibility for the environment.
018	Designing action for sustainability requires an evaluation of past practices, the assessment of scientific and technological developments, and balanced judgments based on projected future economic, social and environmental impacts.	Students design actions to reduce their personal carbon footprints, as well as mitigate the impacts of climate change on their local environment and that of neighbouring regions and countries.
019	Sustainable futures result from actions designed to preserve and/or restore the quality and uniqueness of environments.	Students design actions to reduce their personal carbon footprints, as well as mitigate the impacts of climate change on their local environment and that of neighbouring regions and countries.

Key lesson outcomes

In the *Carbon clues* unit, students begin to develop their understanding of the presence of carbon in most living and non-living things. They are introduced to the idea that carbon can be found everywhere, but is rarely visible in its pure form. Students begin to understand that the movement of carbon from carbon stores, such as trees and underground, into the air can be achieved via burning. Students examine the link between the release of energy from carbon sources to produce useable energy, and the release of greenhouse gas that contributes to the enhanced greenhouse effect and climate change. Students are given the tools and an opportunity to examine their own resource and energy use and are challenged to arrive at solutions that ensure the short- and long-term futures of themselves as individuals and individuals in our Asia-Pacific region.

Teacher background information

Carbon is everywhere

First and foremost, carbon is a substance that can be found in many different forms, such as diamond and carbon black, and, when combined with other substances, can form many familiar compounds, including carbon dioxide (a greenhouse gas).

Carbon can be found in all living things and many non-living things. Everywhere you look, you are bound to see objects that consist of carbon. The carbon in many structures can be stored there indefinitely (e.g. in coal under the ground) or can be burned to release its stored energy. This energy can be produced as heat, and can also be used to generate electricity. However, the result of releasing energy from stored carbon is that carbon dioxide – a greenhouse gas – is often also released into the atmosphere.

This resultant greenhouse gas is the main contributor to the enhanced greenhouse effect, leading to climate change. When the greenhouse effect acts at a normal level, it is able to maintain Earth's average temperature at a level that enables effective survival and growth of living things. However, it is the enhanced greenhouse effect, resulting from excess amounts of carbon dioxide in the atmosphere as a result of carbon intensive human activities, that causes the Earth's temperature to rise beyond normal levels.

Individuals are able to calculate their own carbon footprints, which are a measure of their energy and resource use and an indirect measure of their contribution to climate change. Actions to reduce carbon footprints can be both individual and collective. Individuals have opportunities to collaborate with others, including those in their families and local regions, as well as with their Asia-Pacific neighbours. Changes that occur as a result of collaboration often have many more positive effects for communities, particularly those where livelihoods are less affluent.

Students' conceptions

Taking account of students' existing ideas is important in planning effective teaching approaches to help students learn science. Students develop their own ideas during their experiences in everyday life and might hold more than one idea about an event or phenomenon.

Many students do not connect chemical substances, such as carbon or carbon compounds, to living and non-living structures on the Earth. It is important to demonstrate to students that carbon can look quite different depending on the other substances it combines with and the types of structures it forms.

Students may find the new scientific terms associated with talking about basic matter and substances difficult to grasp. As such, it is particularly important to provide as many concrete examples as possible of carbon and carbon compounds that exist on Earth. When students are introduced to the more abstract concepts of carbon and energy being released from carbon compounds, confusion can arise. It is useful to give some more accessible examples of the release of energy from carbon-based substances, such as the burning of wood or coal, or the decomposition of dying matter, and the subsequent release of carbon dioxide, so that students can begin to comprehend the nature of carbon movement.

Often students' preconceptions about energy are simplistic, e.g. you can get energy from food; when you are tired you have less energy etc. Using these ideas as a starting point and remoulding them in a scientific framework, with correct scientific terms, can allow students to move from the unscientific, simplistic view of energy, to a more sophisticated scientific view of energy as heat or electricity.

Some students may find the link between carbon dioxide, greenhouse gases and climate change a relatively familiar one; however for others, this may be their first introduction to these scientific ideas. However, it is quite common for students to have embedded misconceptions surrounding the terms climate change, global warming and the greenhouse effect.

Often students have misconceptions about the value of the greenhouse effect for life on Earth. That is, they believe that life on Earth is far more successful when the Earth does not experience any greenhouse effect at all. It is important for students to realise that the greenhouse effect has always existed since Earth had an atmosphere, and it is the actions of humans that has contributed to an *enhanced* greenhouse effect, which has caused the Earth's temperature to rise to unnatural levels.

When discussing the effects and impacts of climate change, students can mistakenly assume that 'global warming' means that the world will be a hotter place. While true on a general scale, the effects that are both happening now and forecast for the future are much more intricate and region-based. It is essential that students are introduced to the subtlety of this idea, in order that, over time, they can learn to distinguish one from the other. One means to this end is to use the term 'climate change' in preference to 'global warming'.

Students bring a large variety of attitudes and beliefs to the issue of climate change, its existence, and the role that humans do play, and should play, in its causes and solutions. Each student may already have an opinion on how much they or their families are willing to engage in the science and politics of this issue, as well as how much, or how little, they are prepared to do or feel they can do about its mitigation. This can be a very sensitive issue for some students, as they grapple with their place in the family, their friendship groups and in society at large. However, by reframing the issue to focus on the effects on others, particularly those of our less affluent regional neighbours, students can often feel more comfortable to engage.

It is also important to allow students to feel empowered to create meaningful change to reduce their dependence on non-renewable resources. This can be achieved by creating in students a sense of ownership and control over their own beliefs and actions, and establishing the idea that all positive action, large or small, has value and potential to create positive change.

Safety

Learning to use materials and equipment safely is central to working scientifically. It is important, however, for teachers to review each lesson before teaching in order to identify and manage safety issues specific to a group of students.

The following guidelines will help minimise risks:

- Be aware of the school's policy on safety in the classroom and for excursions and lessons conducted in the outdoors.
- Check students' health records for allergies or other health issues.
- Be aware of potential dangers by trying out activities before students do them.
- Caution students about potential dangers before they begin an activity.
- Instruct students never to taste, smell or eat anything unless they are given permission.
- Discuss and display a list of safe practices for science activities.

Carbon futures program

Out of the classroom and into the bush

Carbon futures is an engaging, inquiry-based program developed by WithOneSeed in association with the Royal Botanic Gardens, Melbourne.

The program is available as a field trip to the Royal Botanic Gardens, Cranbourne and Melbourne, yet most elements of this program can also be completed within a school setting. Specific elements of the *field trip* are embedded within the lessons of this unit.

Carbon futures aims to 'plant' seeds to enable Australian students to better understand their environment, the carbon cycle and their rights and responsibilities as citizens of the Asia-Pacific region.

The *Carbon futures* program takes students out of the classroom and into the bush to gain a practical look at carbon in the environment. Students will learn about how carbon works in different natural systems through ocean acidification experiments and measuring carbon in trees. Students will also discover the many other services a forest has to offer people anywhere on the planet. The program also aims to connect schools in Australia with subsistence school communities in Timor Leste, as part of WithOnePlanet's open education and WithOneSeed's community forestry initiatives.

Teachers can arrange a *Carbon futures field trip* through the Royal Botanic Gardens Education Program.

Primary school bookings: http://www.rbg.vic.gov.au/learn/programs/primary-cranbourne
http://www.rbg.vic.gov.au/learn/programs/primary-melbourne

Secondary schools bookings: http://www.rbg.vic.gov.au/learn/programs/secondary-cranbourne
http://www.rbg.vic.gov.au/learn/programs/secondary-melbourne

Carbon futures program info video – http://vimeo.com/51257037

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Open education
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Royal Botanic Gardens Melbourne