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**Y9**

 Bushfire and ice • Lesson 1 • Exploring bushfires

**Lesson 1**

**LAUNCH**

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| To read the most recent version of this lesson, download associated resources, and view embedded professional learning including classroom videos and work samples, visit: [https://scienceconnections.edu.au/teaching-sequences/year-9/bushfire-and-ice/lesson-1-exploring-bushfires](https://scienceconnections.edu.au/teaching-sequences/year-9/bushfire-and-ice/lesson-1-exploring-bushfires?utm_source=docx&utm_medium=lesson_1&utm_campaign=BI) |

# Lesson overview

Students examine the prevalence of bushfires, their causes and how people are impacted.

## Key learning goals

Students will:

* examine the impact a bushfire has on people in the community.
* explore how the prevalence of bushfires varies across Australia and vegetation types.
* use argumentation to justify a claim on the main cause of bushfires.

Students will represent their understanding as they:

* use an empathy map to explore the impacts of bushfire on a community.
* group and classify different Australian vegetation types.
* use argumentation to defend a decision on the main cause of bushfires.

## Assessment advice

In the Launch phase, assessment is diagnostic.

Take note of students’ understanding and ability to:

* describe a bushfire.
* identify emotions from people’s conversations and body language, and respond effectively.
* construct an argument.
* provide alternative explanations for a satellite observed hotspot.

## List of materials

**Whole class**

* **Bushfire and ice Resource PowerPoint**
* Sticky notes
* Access to internet and YouTube for videos on bushfires
* **Australian ecosystems answers sheet**

**Each group**

* Set of photos from **Australian ecosystems Resource sheet** (these photos could be laminated and cut for reuse)
* **Trustworthy Resources sheet** (optional)

**Each student**

* Individual Science notebook
* **Bushfire empathy map**

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| **Lesson routine** | **Estimated time** | **Task type** |
| **Experience & Empathise** | 15 minutes | Whole class/Small group |
| **Elicit** | 20 minutes | Whole class/Small group |
| **Anchor** | 15 minutes | Whole class/Individual |
| **Connect** | 15 minutes | Whole class/Individual |

# Launch

## Experience & Empathise • Bushfire impact

Introduce the topic of bushfires by:

* recognising any recent local bushfires.
* identifying students who may have had friends or family affected by bushfires.
* discussing the importance of understanding and planning for bushfires in the future.

(Slide 3) Explain to students the purpose of an empathy map: to capture the attitudes and behaviours of people experiencing challenges such as bushfire.

Divide the students into groups and allocate **one** section of the **Bushfire empathy map** to each group (Think, Feel, Say, Do). Explain that each group should capture what they see and hear in their notebooks during the discussion or watching the video.

Discuss with students recent bushfires in your area or show a video of a recent bushfire. For example: [Homes lost and damaged in bushfire that’s ravaged Perth's north | 9 News Australia (1:07)](https://www.youtube.com/watch?v=feWwN2-swIw). Each group should:

* **Think:** Listen for phrases that identify what people are thinking. These phrases usually start with “I think…’ or ‘I believe…’.
* **Feel:** Watch the expressions of the people in the video. Do they look helpless, happy, thankful, sad? What are they talking about when they show these emotions?
* **Say:** What are people saying during the video? Write direct quotes or key phrases of what is being said. Make sure you note what they are referring to in each quote.
* **Do:** Identify the people in the video (foreground and background) and how they are related to each other. What are people doing in the videos? How are they acting before, during and after they speak?

✎ STUDENT NOTES: Complete the allocated section of the **Bushfire empathy map.**

Encourage individual groups to compare their observation notes for their section of the empathy map. Groups then share their observations with the class.

Provide each group with sticky notes to record the group’s observations for their section of the empathy map. Collate the observations into a whole class empathy map.

Identify similar ideas/observations in each quarter of the map and cluster them together. Discuss the observations that students made. Encourage students to record the class observations in their individual empathy maps.

**Potential discussion prompts**

* *What did the people say about the bushfire? How did they describe what happened?*
* *Did what they say match their thinking?*
* *Did they describe or think about what had happened (the past)?*
* *Did they describe or think about what was happening around them (the present)?*
* *Did they describe or think about what they needed to do next (the future)?*
* *Did their thoughts match their actions (the ‘do’)?*
* *How did you feel watching the video? Did your emotions mirror that of the people in the video?*
* *What strategies could you use to manage your emotions?*
* *Would these strategies help if you were talking with people affected by the bushfire directly? Why or why not?*

✎ STUDENT NOTES: Update all sections of the **Bushfire empathy map** with the class observations.

## Elicit • Bushfires across Australia

(Slide 4) Identify what students know about bushfires, where they occur and how they behave.

**Potential discussion prompts**

* *Has Australia always had bushfires?*
* *Why are we so worried about bushfires now?*
* *What makes a fire a bushfire?*
* *Is a fire in grassland called a bushfire? Why? Why not?*
* *Do bushfires occur in all parts of Australia?*
* *What different types of environments occur across Australia?*
* *Do you think a fire behaves the same in all environments? Why do you think that?*

(Slide 5) Divide students into groups and provide each group with a set of the ecosystem photos in the **Australian ecosystems Resource sheet**. Ask students to group the photos into similar environments and to identify a title for each category.

(Slide 6) Discuss how students sorted and named the categories, and how they were similar and different across each group.

**Potential discussion prompts**

* *How did your group decide the categories?*
* *How did the categories vary between each group of students? What was similar and what was different?*
* *Is there one environmental category that would be most at risk of bushfire?*
* *What evidence would you need to support your claim?*

(Slide 7) Show the map of Australia that illustrates the different climate zones of Australia, including the savanna woodland zone, savanna grassland zone, and temperate grassland zone, and the frequency of fires.

Discuss the definition of each environment type, referring back to and comparing it to each of the Australian environment images students just sorted.

* Black outline: savanna woodland zone—scattered trees and shrubs forming a light canopy
* Green outline: savannah grassland zone—little to no trees or shrubs
* Red outline: temperate grassland zone—hot summers and cold winters produce grassland with occasional eucalyptus trees

Identify that temperate woodland (trees and shrubs that provide a canopy in variable climates that are cold in winter) and rainforests (closed canopies with moisture-dependent plant-life) are not shown on this map. Discuss how the solid colours represent the fire frequency.

Allow students the opportunity to re-categorise their photos as required.

Suggested answers are provided in **Australian ecosystems Teacher resource sheet**

(Slide 8) Lead a discussion to draw out the correlation between the identified environment zone and the frequency of fire, and why this may occur.

**Potential discussion prompts**

* *What are the features of the three types of environments?*
* *Which environment zone are we located in?*
	+ Identify the environment pictures that are relevant to your local environment. Discuss the similarities and differences.
* *Do the descriptions/images fit with your experience/understanding of our local area?*
	+ Some students who live in suburban areas may have a limited or artificial experience of the environment zone in which they live. They may only have seen and experienced man-made suburban areas and will need support, via reference to the images, to build a picture of what these environments look like.
* *Which zones have the most fires recorded between 1988-2019?*
	+ Savanna woodlands. This may come as a surprise to students as the media generally reports on bushfires in heavily populated areas in the southern parts of Australia.

✎ STUDENT NOTES: Working in groups, identify and record what you know about how bushfires behave in each of these environments.

**Potential discussion prompts**

* *What (in the pictures) will burn in a bushfire?*
* *What makes a bushfire more dangerous in our environment?*
* *How do bushfires spread?*
* *What makes a bushfire spread faster?*
* *Have we always had bushfires in our area??*
* *Are bushfires occurring more often?*
* *What causes most bushfires?*

✎ STUDENT NOTES: Record any questions about the ways bushfires behave in different environments.

## Anchor • Lightning, people and bushfires

**Pose the question:** *What is the main cause of bushfires?*

Ask students to list all the possible causes of bushfires. Collect their ideas on sticky notes or written on a board.

Group these ideas into a few categories. These could include accidental, arson, natural/storms/lightning, hazard reduction etc.

(Slide 9) Identify the two claims that ‘people’ or ‘lightning’ are the main causes of bushfires.

Discuss what evidence would be needed to make a claim about which category is the main cause of a bushfire.

(Slide 10) Discuss the lightning density map as evidence for one of the claims.

**Potential discussion points**

* *What is this map showing?*
	+ Average annual number of lightning flashes that make contact with the ground.
* *What do the numbers represent?*
	+ The number of times lightning was recorded from the International Space Station Lightning Imaging Sensor.
* *Is it from a reliable source? How do we know?*
* *Where does the most frequent lightning occur?*
	+ Northern parts of Australia.
* *Why do you think this occurs?*
	+ More likely to have big storms in this area.

(Slide 11) Display or distribute a copy of the **Trustworthy resources Resource sheet**. Discuss the reliability of each form of evidence and how it could be used to support one of the original two claims.

Discuss the importance of identifying the source of data and the reliability of the source. Links are provided so that the websites can be evaluated. Students should identify that the blogs do not provide data to back their claims and therefore cannot be used as evidence.

**Potential discussion prompts**

* *Where does each of these pieces of information come from?*
* *Who can we tell if the source of the data is reliable?*
	+ The blogs are not backed by data that is rigorously collected and represented. They do not provide where their information comes from. Pictures are designed to evoke emotions rather than provide information. These are not reliable sources.
* *What does the evidence show?*
	+ The number of arson attacks is increasing. Evidence of bushfires show largest single cause of bushfires is lightning.

Optional: The chart from the United Nations Office for Disaster Risk Reduction is originally sourced from an article in [The Conversation](https://theconversation.com/open-data-shows-lightning-not-arson-was-the-likely-cause-of-most-victorian-bushfires-last-summer-151912) that was produced by a Monash University Honours student (in collaboration with their supervisors). Curious students can be encouraged to locate the original source of the work.

(Slide 12) Introduce the key elements of argumentation including making a claim, supplying evidence that supports the claim, and reasoning that links the evidence to the claim.

✎ STUDENT NOTES: Make a claim about the main cause of bushfires, providing reliable evidence (Slides 13 and 14) and reasoning to support the claim.

(Slide 15) Some students may agree that both claims are correct. The focus is on the reasoning they use to support their decision.

**Potential discussion prompts**

* *What do you think is the main cause of bushfires?*
* *Why do you think that?*
* *What evidence did you use to make your decision?*
* *How does that link to the claim?*
* *Can you think of another argument for your view?*
* *Can you think of evidence that might make you rethink your decision?*

## Connect • Make it local

(Slide 16) Demonstrate how the [Firewatch website](https://myfirewatch.landgate.wa.gov.au/map.html) uses satellites to detect hotspots across Australia over the previous 72 hours. A hotspot is an area of high infrared intensity that is detected by satellite image. This means it could be a heat source such as heavy industry and gas fires. A bushfire may not be visible if there is a lot of smoke or cloud, or the fire is too cool.

Zoom the map into the local area to identify any potential hotspots in your local area.

NOTE: Vegetation maps can be selected on the LHS of the image. Vegetation is updated weekly and is sourced through google maps. Burnt areas for the year can also be selected (updated monthly).

Use the local government incident updates to identify if there has/is a fire in the area, or if there is another cause for the hotspot.

(Slide 17) Discuss the potential impact if a fire was to occur in your local area.

**Potential discussion prompts**

* *If we had a bushfire in our area, where would it likely occur?*
* *What might be the cause?*
* *Who might be most affected?*
* *How might they be affected, either directly or indirectly?*
	+ Directly includes loss of home, loss of work, loss of family, and health effects of bushfire smoke (people with lung disease/asthma/cardiac disease/babies and young children, elderly, etc).
	+ Indirectly includes mental health issues (including anxiety), disrupted schooling, and loss of community.

Optional: Invite a local firefighter into the classroom for an interview.

✎ STUDENT NOTES: Record the discussion using a T-diagram.



Outline the Act(ion) that students will take at the end of this teaching sequence.

Students will prepare a fire action plan for themselves, members of their community or visitors to the region. This could take the form of:

* Persuasive texts
* Infographics
* Video presentation
* Brochures
* Storybook
* Advertisements
* News broadcast
* Website page
* Public education campaign
* Local environment plan

### Reflect on the lesson

Students might investigate the last bushfire that was in their area and write a short news article that includes:

* the area burnt.
* the effort taken to get the fire under control.
* who was affected.
* how they were affected.
* any recovery efforts that were made to support plants and animals.

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**Y9**

 Bushfire and ice • Lesson 2 • Fire and combustion reactions

**Lesson 2**

**INQUIRE**

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| To read the most recent version of this lesson, download associated resources, and view embedded professional learning including classroom videos and work samples, visit: [https://scienceconnections.edu.au/teaching-sequences/year-9/bushfire-and-ice/lesson-2-fire-and-combustion-reactions](https://scienceconnections.edu.au/teaching-sequences/year-9/bushfire-and-ice/lesson-2-fire-and-combustion-reactions?utm_source=docx&utm_medium=lesson_2&utm_campaign=BI) |

# Lesson overview

Students conduct a series of activities that explore the reactants and products of a combustion reaction.

## Key learning goals

Students will:

* identify that mass is lost during the combustion of a candle.
* identify that carbon dioxide and water are produced during the combustion of a candle.
* identify that oxygen is required for a combustion reaction.
* use argumentation (claim, evidence, reason) in discussing their findings.

Students will represent their understanding as they:

* identify reactants and products in a combustion reaction
* draw a fire triangle.
* identify assumptions and limits to the validity of a method.
* conduct classroom discussion and argumentation processes.

## Assessment advice

In this lesson, assessment is formative.

Feedback might focus on:

* students’ identification of the reactants and products in a chemical reaction.
* students’ ability to generate a word equation for combustion.
* students’ identification of assumptions of the gases that are used/produced in the combustion reaction. Can they determine the impact these assumptions could have on the ability to generate a word equation for combustion?
* students’ ability to analyse methods and conclusions to identify facts or premises that are taken for granted to be true (i.e. oxygen is needed for combustion) and evaluate the reasonableness of those assumptions.
* students’ explanation of the validity of the activities used to identify the products and reactants of a combustion reaction.

**Potential summative task**

Students working at the achievement standard should:

* explain how scientific knowledge is validated and refined, including the role of publication and peer review.
* identify the reactants and products in a chemical reaction.
* compare information provided by the activities to generate a word equation for combustion.
* analyse and connect data and information to identify and explain patterns, trends, relationships, and anomalies.
* analyse the impact of assumptions and sources of error in methods and evaluate the validity of conclusions and claims.
* construct logical arguments based on evidence to support conclusions and evaluate claims.
* select and use content, language, and text features effectively to achieve their purpose when communicating their ideas, findings, and arguments to specific audiences.

Refer to the [Australian Curriculum content links on the Our design decisions tab](https://scienceconnections.edu.au/teaching-sequences/year-9/bushfire-and-ice?tabIndex=2) for further information.

## List of materials

**Whole class**

* **Bushfire and ice Resource PowerPoint**
* Sticky notes
* Access to the internet and YouTube for videos on bushfires
* Straw (for demonstration)
* Lime water (for demonstration)
* **Optional:** Flaming flour demonstration requires funnel, plastic tubing, Bunsen burner, matches, plain flour, safety glasses
* High Tech option: Carbon dioxide sensor

**Each group**

The following activities should be set up around the room so that students will visit each area to identify the key aspects of a combustion reaction. Provide the information for each activity (included in the Combustion reactions Resource sheet) at each station.

**Activity 1**

* Tealight candle
* Matches
* Scales
* Stopwatch

**Activity 2**

* Gloves
* Tealight candle
* Small weight or stand for the candle
* Matches
* Petri dish
* 10-15 mL lime water
* Glass jar that fits over candle
* **Optional**: carbon dioxide meter

**Activity 3**

* Tealight candle
* Matches
* Petri dish
* Glass jar that fits over candle
* Scales

**Each student**

* Individual science notebook
* Safety glasses, lab coat and hair ties
* **Combustion reactions Resource sheet**

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| **Lesson routine** | **Estimated time** | **Task type** |
| **Re-orient** | 5 minutes | Whole class |
| **Question** | 10 minutes | Whole class |
| **Investigate** | 30 minutes | Small group |
| **Integrate** | 15 minutes | Small group/Whole class |

# Inquire

## Re-orient

Revisit the main causes of bushfires and their prevalence in the local area, focusing on:

* The main individual cause is lightning.
* People cause fires through arson, accidents and hazard reduction burns.

## Question • Flaming fire

Watch the video/s [Fire and flame 05 – Burning flour (1:36)](https://www.youtube.com/watch?v=n-tD2bfj3Is) and/or [073 Flaming Flour2 (4:49)](https://www.youtube.com/watch?v=1E2lvKnrKIw&t=67s).

Alternatively, demonstrate the phenomena in the classroom:

1. Wear safety glasses.
2. Light a Bunsen burner.
3. Connect a funnel to one end of plastic tubing.
4. Place a small amount of flour in the funnel.
5. Place the funnel below and to the side of the flame (pointing away from you and the students).
6. Gently blow into the other end of the tubing, so that a fine mist of flour travels into the flame (away from you and the students).

SAFETY NOTE: If completing your own demonstration, consider the location of heat or smoke detectors, and the position of students or colleagues. Consider using a Perspex barrier between the flame and students for the demonstration.

**Pose the question:** *Is it the heat or the flame that makes the flour catch alight?*

## Investigate • Combustion reactions

(Slide 19) Encourage students to make a claim about the cause of the fire—is it the flame or the heat? Ask students for evidence of their claim, and reasoning that links the evidence to the claim. Alternatively, ask students what evidence they would need and how they could test their claim.

**Potential discussion prompts**

* *What evidence/observation do you have to support your claim?*
* *Would the flour catch fire if you did this over a radiant heater?*
	+ Yes, if hot enough.
* *What would happen if a match was dropped into a container full of settled flour?*
	+ The flame would go out. [Flour Fireball (1:39)](https://www.youtube.com/watch?v=0nwRxFYG17Y&t=24s) is an example video demonstration.

Discuss how a fire needs a fuel, a heat source and oxygen.

 **Potential discussion prompts**

* *Describe what happened in the demonstration.*
* *Was this a chemical or physical reaction? How do we know?*
	+ This was a chemical reaction: light and heat were given off.
* *Why did the flour catch alight?*
	+ It is a fuel.
* *Why doesn’t the flour catch alight when it is sitting in the container?*
	+ No heat. And small particles of flour have a greater surface area for oxygen to react when near a heat source.
* *Would the flour catch alight if it was in a lump sitting in a spoon? Why or why not?*
	+ It would be harder for the flour to catch alight as it is more difficult for oxygen to reach the individual particles of flour.

(Slide 20) Introduce standard word equation format.

✎ STUDENT NOTES: Record the general equation:

$$Reactant+reactant\rightarrow product+product$$

(Slide 21) Identify one of the reactants as ‘Fuel’ (such as the flour dust).

Explain that students are going to identify the remaining parts of a combustion reaction.

Provide students with the **Combustion reactions Resource sheet**. Divide students into groups and introduce the following three activities.

The activities should be set up around the room, with information for each activity at each station. All students should be wearing safety glasses.

To prepare students for Activity 2, demonstrate how lime water becomes cloudy when carbon dioxide is bubbled through it by gently blowing through it with a straw.

SAFETY NOTE: Take care doing this so that you do not inhale the lime water and wear safety glasses to avoid splashing it in your eyes. If contact is made with your skin, wash the area with water.

**Activity 1: Burning candle**

Question: Does the candle change weight when it is burnt for 2 minutes?

Observation: Mass is lost when a candle is burnt.

Infers: Gas is produced during a combustion reaction.

**Potential discussion prompts**

* *What does the conservation of mass tell us about chemical reactions?*
	+ Mass is not gained or lost in a reaction.
* *If the candle lost mass, where does it go?*
	+ Becomes a gas.
* *Do you think the gas is the candle wax or something new?*
	+ Unable to tell. Need Activity 2 and 3.

**Activity 2: Testing for a gas**

Question: What is produced during a combustion reaction?

Observation: Lime water becomes cloudy.

Infers: Carbon dioxide is produced during combustion.

HIGH TECH option: Use a carbon dioxide meter to measure the carbon dioxide levels in the glass jar.

 **Potential discussion prompts**

* *What happened to the candle when the glass jar was put over the top?*
	+ The flame went out.
* *Why do you think this happened? What claim can you make?*
	+ That air is needed for the candle to burn/combust. Cannot assume that it is oxygen in this activity.
* *Can we tell what it is in the air that is needed for combustion?*
	+ No.
* *What types of elemental gases are found in air?*
	+ Oxygen, nitrogen, carbon dioxide, hydrogen are the main gases.
* *How did the lime water change during the activity?*
	+ It became cloudy.
* *What causes the lime water to change/become cloudy?*
	+ Carbon dioxide.
* *What claim can you make as a result of this change in the lime water?*
	+ Carbon dioxide is produced during combustion.
* *What evidence supports your claim?*
* *Can you provide reasoning to link the evidence and the claim?*

**Activity 3: Candle in a jar**

Question: What is lost or produced during a combustion reaction?

Observation: Weight does not change when the glass jar is put over the flame.

Infers: Gas is lost during a combustion reaction.

Observation: The flame goes out without a fresh supply of air.

Infers: Combustion reactions need something present in the air.

**Potential discussion prompts**

* *What happened to the candle when the glass jar was put over the top?*
	+ The flame went out.
* *Why do you think this happened? What claim can you make?*
	+ That air/oxygen is needed for the candle to burn/combust.
* *Can we tell what gas in air is needed for the combustion reaction?*
	+ No.
* *What types of elemental gases are found in air?*
	+ Oxygen, nitrogen, carbon dioxide, hydrogen are the main gases.
* *How did the weight change (or not change) in this activity?*
	+ No change.
* *How is this activity different to activity 1?*
	+ The jar trapped the gas produced.
* *What claim can you make as a result of the lack of weight change?*
	+ Gas is produced during combustion.

## Integrate • Fire triangles

(Slide 22) Discuss the importance of scientists collaborating to bring together different ideas and claims so that they develop a big picture of what is happening in chemical reactions.

Ask students to:

* write all their claims and observations/evidence on sticky notes (one note for each claim and evidence).
* group their claim/reasoning/evidence notes into ‘Reactant related’ and ‘Product related’ groups.

Sticky notes can be used to arrange claims, evidence and reasoning.

(Slide 23) Discuss the importance of not making assumptions when making observations and ensuring that you have evidence to support any claims that are being made.

**Potential discussion prompts**

* *What can we tell from each activity and what can we not tell from the activity?*
* *What is an assumption?*
* *What assumptions would it be easy to make with one of these activities?*
* *What makes an experiment valid?*
	+ An experiment is valid if it measures what was intended and is repeatable. It is not valid if inaccurate assumptions are made, or the experiment gives varying results.
* *What key things are needed to start a combustion reaction?*
	+ Identify fuel, oxygen and heat as the fire triangle.
* *What types of substances could be a fuel?*

Discuss the three elements that are required for a combustion reaction: heat, fuel, oxygen.

✎ STUDENT NOTES: Draw your own version of a fire triangle. (Slide 24)

 Discuss how students’ observations can identify the reactants and products of a combustion reaction.

**Potential discussion prompts**

* *Where do you put ‘heat’ on the reactant/product equation?*
	+ Heat is not a reactant. It is energy (not matter or a separate entity).
* *What are the products of combustion?*
	+ Claim: carbon dioxide → Evidence: Lime water showed evidence of carbon dioxide being produced.
	+ Claim: water → Evidence: liquid on the inside of jar. (*How do we know it is water? What test could we do?)*
* *What are the reactants of a combustion reaction?*
	+ Claim: Fuel → Evidence: Flour, matches and candle wax needed to burn.
	+ Claim: Oxygen → Evidence: This cannot be confirmed in these experiments, but the work of other scientists has identified that oxygen is needed for combustion to occur.

 (Slide 25) Provide students with the completed word equation for the combustion reaction.

✎ STUDENT NOTES: $Fuel+Oxygen \rightarrow Carbon dioxide+Water$

Optional: Discuss how oxygen by itself does not burn. A fuel is needed. See [*Fire and flame 12 – Oxygen balloon* (0:59)](https://www.youtube.com/watch?v=BVFT3oAZImo)for an example video demonstration.

Discuss what types of things act as fuel in a bushfire. Encourage students to share their ideas.

✎ STUDENT NOTES: Record your ideas about bushfire fuel.

Optional: Watch the video [*Fuel and fuel types* (1:09)](https://www.youtube.com/watch?v=kEHspanF_G0&t=10s).

### Reflect on the lesson

You might:

* discuss the answer to the question: *‘*Can combustion occur in space?’ (Slide 26). Claims 1 and 2 are correct.
* watch the video [*Why fires burn* (2:03)](https://www.science.org.au/curious/video/why-fires-burn) as a summary.
* select one of the videos from the [*Fire and Flame - Peter Wothers Lecture* playlist](https://www.youtube.com/playlist?list=PLLnAFJxOjzZvK056qKGTumPUkiCJb0W6B) to identify some of the ways to increase or decrease a combustion reaction.
* re-examine the intended learning goals for the lesson and consider how they were achieved.
* discuss how students were thinking and working like scientists during the lesson focusing on the process of argumentation.

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**Y9**

Bushfire and ice • Lesson 3 • Carbon dioxide and the carbon cycle

**Lesson 3**

**INQUIRE**

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| To read the most recent version of this lesson, download associated resources, and view embedded professional learning including classroom videos and work samples, visit: [https://scienceconnections.edu.au/teaching-sequences/year-9/bushfire-and-ice/lesson-3-carbon-dioxide-and-carbon-cycle](https://scienceconnections.edu.au/teaching-sequences/year-9/bushfire-and-ice/lesson-3-carbon-dioxide-and-carbon-cycle?utm_source=docx&utm_medium=lesson_3&utm_campaign=BI) |

# Lesson overview

Students model the movement of carbon dioxide produced by combustion through the atmosphere, hydrosphere, biosphere, and geosphere.

## Key learning goals

Students will:

* model the movement of carbon dioxide through the atmosphere, hydrosphere, biosphere, and geosphere.

Students will represent their understanding as they:

* record data and graph the amount of time that carbon spends in different parts of its cycle.
* draw a representation of the carbon cycle.

## Assessment advice

In this lesson, assessment is formative.

Feedback might focus on:

* students’ ability to draw graphs of the movement of carbon.
* students’ ability to represent the movement of carbon through Earth's sphere.

**Potential summative task**

Students working at the achievement standard should:

* explain how interactions within and between Earth's spheres affect the carbon cycle.
* analyse and connect data and information to identify and explain patterns, trends, relationships, and anomalies.
* construct logical arguments based on evidence to support conclusions and evaluate claims.
* select and use content, language, and text features effectively to achieve their purpose when communicating their ideas, findings, and arguments to specific audiences.

Refer to the [Australian Curriculum content links on the Our design decisions tab](https://scienceconnections.edu.au/teaching-sequences/year-9/bushfire-and-ice?tabIndex=2) for further information.

## List of materials

**Whole class**

* **Bushfire and ice Resource PowerPoint**
* 7 dice
* 1 set of Station cards from the **Carbon cycle game Resource sheet**

**Each group**

* Sticky notes

**Each student**

* Individual science notebook
* Data sheet from **Carbon cycle game Resource sheet**

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| **Lesson routine** | **Estimated time** | **Task type** |
| **Re-orient** | 5 minutes | Whole class |
| **Question**  | 10 minutes | Whole class |
| **Investigate** | 20 minutes | Whole class |
| **Integrate** | 20 minutes | Whole class/Individual |

# Inquire

## Re-orient

Recall the fire triangle from the previous lesson and discuss how it relates to a bushfire.

**Potential discussion points**

* *What are the reactants in a combustion reaction?*
	+ Fuel and oxygen.
* *What else do you need in a combustion reaction?*
	+ Heat.
* *What are the products in a combustion reaction?*
	+ Carbon dioxide and water.
* *What type of materials are used to fuel a bushfire?*
	+ Dried leaves and grasses, fine bark most commonly.

## Question • Where does the carbon dioxide go?

(Slide 28-29) Discuss the 2020 bushfire shown in the photo from the European Space Agency and remind students of what occurs during a combustion reaction.

**Potential discussion prompts**

* *What makes up the smoke shown in the picture?*
	+ Carbon dioxide, water, and small particulate matter—often containing carbon.
* *What is carbon?*
	+ An element, single type of atom.
* *What does carbon look like?*
* *What molecules in the process of combustion of fuel contain carbon?*

**Pose the question:** *Where does the carbon and carbon dioxide go?*

## Investigate • Carbon cycle game

(Slide 30) Introduce the **Carbon cycle game**.

Discuss how carbon is an essential element in many different molecules. Provide examples of the types of molecules that contain carbon.

**Potential discussion prompts**

* *What types of molecules might contain carbon?*
	+ Carbon dioxide, DNA, enzymes, methane (all organic molecules).
* *Where do we find carbon dioxide?*
	+ The atmosphere.
* *Where else might we find carbon?*
	+ Students may identify rocks and living things.

(Slide 31) Discuss how scientists group together different parts of Earth into systems called spheres, including the atmosphere (air), geosphere (mantle, earth, soil and rocks), hydrosphere (water), and biosphere (living things).

✎ STUDENT NOTES: Record the definition and examples of geosphere, biosphere, hydrosphere, and atmosphere.

**Potential discussion prompts**

* *Why do you think we include all the air around the Earth under the one term ‘atmosphere’?*
	+ So all scientists use the same term, and can understand each other's research. What happens in the atmosphere over one country, also affects other countries.
* *What term could we use to group all the water on the Earth?*
	+ Hydrosphere.
* *What other groups could we use? Other than air and water, what other things do we need to consider?*
	+ Geosphere: all the mantle, earth, soil, and rocks. Biosphere: all living things.
* *Is carbon found in all these spheres? What type of carbon-containing molecules might be found in each of these spheres?*
	+ Atmosphere: carbon dioxide.
	+ Geosphere: calcium carbonate in limestone and marble, coal, and fossil fuels.
	+ Hydrosphere: dissolved carbon dioxide and other molecules.
	+ Biosphere: DNA, glucose, and enzymes.

Provide students with the **Carbon cycle game Resource sheet** and explain that they will role-play as carbon atoms travelling through the carbon cycle. Show the students the station cards that are placed at different points (with the dice) in the room.

Divide the class into seven equal groups and assign them to one of the seven carbon locations. Encourage students to read the cards and identify the different parts of the room that they could move to next.

Each student should line up to take their turn to roll the dice and move to another part of the carbon cycle, recording their movements after each toss.

✎ STUDENT NOTES: Record your movements as a carbon atom on the **Carbon cycle game Resource sheet.**

## Integrate • Representing the carbon cycle

(Slide 32) Discuss how the different parts of the carbon cycle move at different speeds.

**Potential discussion prompts**

* *Did anyone become ‘stuck’ at any part of the carbon cycle?*
	+ These are called carbon sinks.
* *Did some parts of the carbon cycle move faster than others?*
	+ Fast cycling occurs within and between the biosphere (plants-animals) and the atmosphere (respiration and decay).
* *Did some parts of the carbon cycle move slower than other parts?*
	+ There is slow cycling between the atmosphere, hydrosphere and geosphere (carbon becomes trapped in the hydrosphere and geosphere).
* *How effective would this model be in predicting the levels of carbon in the different spheres*?
	+ Very limited as only a small number of carbon atoms are moving over a short time.
* *What are some of the limitations of using modelling to test a science concept?*
	+ It doesn’t always show everything. The nature of a model is for it to be limited to our current understanding. Models become more complex as our understanding grows.
* *How could a more accurate model be made?*
	+ Collect a large amount of data on the levels of carbon in different locations change over long lengths of time. Use a computer to analyse the data and generate a model.

✎ STUDENT NOTES: Draw a column graph of the amount of time (number of turns) you spent in each sphere, to show the slow and fast sections of the carbon cycle.

**Potential discussion prompts**

* *Where does the graph suggest most carbon spent their time?*
* *How long does it take for a rock to break down?*
* *Do you think this is reflected in the length of time the carbon spends in the geosphere?*
* *How could the carbon in the geosphere be released faster?*
	+ Through combustion of fossil fuels*.*
* *What have you heard about carbon dioxide levels in the atmosphere? (Revisit this in lesson 4.)*
* *How could we support long-term storage of carbon?*

(Slide 33) Discuss how this graph and the carbon cycle can be represented in a diagram that shows the movement of carbon.

✎ STUDENT NOTES: Draw a carbon cycle diagram. Revisit each of the stations from the carbon cycle game if required.

Create a gallery walk where students walk around and examine each other’s carbon cycle. Encourage them to identify key things that they think are an effective way to communicate. Sticky notes can be used to make notes on ways to improve on their diagrams.

Discuss key features in different diagrams that illustrate how carbon moves through the different spheres.

✎ STUDENT NOTES: Make any changes to your diagrams.

**Optional:** Watch the video [Real world: The carbon cycle – Essential for life (5:43)](https://www.youtube.com/watch?v=hgFpvDNfXOk).

### Reflect on the lesson

You might:

* use the carbon cycle diagrams to identify ways to:
	+ encourage carbon to enter the slow part of the carbon cycle.
	+ reduce the release of carbon from the slow carbon cycle.
* identify current carbon capture systems that are being used.

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**Y9**

Bushfire and ice • Lesson 4 • Measuring biomass

**Lesson 4**

**INQUIRE**

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| To read the most recent version of this lesson, download associated resources, and view embedded professional learning including classroom videos and work samples, visit: <https://scienceconnections.edu.au/teaching-sequences/year-9/bushfire-and-ice/lesson-4-measuring-biomass> |

# Lesson overview

Students measure the biomass in a tree and use a spreadsheet to determine the corresponding amount of carbon dioxide removed from the atmosphere.

## Key learning goals

Students will:

* determine the amount of carbon that is stored in the biomass of a local tree.
* calculate the amount of carbon removed from the atmosphere to produce the biomass.

Students will represent their understanding as they:

* calculate the biomass of a tree.
* use a spreadsheet to calculate the carbon present in the tree.
* use a spreadsheet to calculate the amount of carbon dioxide removed from the atmosphere during the growth of the tree.

## Assessment advice

In this lesson, assessment is formative.

Feedback might focus on:

* students’ ability to measure and calculate the biomass of a tree.
* students’ ability to use spreadsheets to calculate the amount of carbon dioxide that was removed from the atmosphere.

**Potential summative task**

Students working at the achievement standard should:

* analyse and connect data and information to identify and explain patterns, trends, relationships, and anomalies.
* analyse the impact of assumptions and sources of error in methods.
* construct logical arguments based on evidence.
* evaluate the validity of conclusions and claims.
* select and use content, language, and text features effectively to achieve their purpose when communicating their ideas, findings, and arguments to specific audiences.

Refer to the [Australian Curriculum content links on the Our design decisions tab](https://scienceconnections.edu.au/teaching-sequences/year-9/bushfire-and-ice?tabIndex=2) for further information.

## List of materials

**Whole class**

* **Bushfire and ice Resource PowerPoint**
* High Tech option: GPS receiver unit
* Access to trees with a base circumference of at least 50cm

**Each group**

* Tape measure

**Each student**

* Access to spreadsheet software (i.e. Excel)
* **Measuring carbon storage Resource sheet**. Note that the last page of this sheet is a quick reference guide, for students who may have difficulty performing the required calculations on a spreadsheet. Consider which students in your class may need this support.

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| **Lesson routine** | **Estimated time** | **Task type** |
| **Re-orient** | 5 minutes | Small group |
| **Question** | 10 minutes | Small group |
| **Investigate** | 30 minutes | Small group |
| **Integrate** | 20 minutes | Whole class/Individual |

# Inquire

## Re-orient

Revise the carbon cycle diagram and graph from the previous lesson.

Discuss how carbon could be shifted into the slow cycle.

## Question • Carbon Sink

(Slide 35) **Pose the question:** *How do trees take in and store carbon?*

**Potential discussion prompts**

* *Where do plants get their carbon from?*
	+ Carbon dioxide in the atmosphere.
* *What do plants do with the carbon?*
	+ Through photosynthesis the carbon dioxide is combined with water to produce glucose sugar and oxygen molecules. This process transforms light energy into chemical energy.
* *What carbon molecules are there in the plants?*
	+ Genetic material (DNA), proteins, enzymes and sugars

**Pose the question:** *How much carbon is stored in the plants in our school grounds?*

## Investigate • Local biomass

Discuss how measuring biomass (the mass of dried renewable organic material that makes up plants and animals) is a way of determining the amount of carbon stored in plants.

**Potential discussion prompts**

* *What carbon molecules are there in the plants?*
	+ Genetic material (DNA), proteins, enzymes and sugars.
* *What parts of a tree might contain carbon?*
	+ All parts of the tree (trunk, leaves, branches, roots).
* *How could we measure the amount of material that there is in a tree?*
* *What could we measure on a tree that would tell us how big it is?*
* *Do all trees have trunks?*
	+ No. And some trees have different types of trunks (hard wood trees are more dense than soft wood trees). But we could use it for a guide. Scientists use it for estimates.

(Slide 36) Explain that students are going to measure the biomass of a tree. Provide students with a copy of the **Measuring carbon storage Resource sheet**.

NOTE: The last page of **Measuring carbon storage Resource sheet** contains a quick reference guide for students who may have difficulty performing the required calculations on a spreadsheet. Consider which students in your class may need this support.

Depending on the number of trees in the school environment, divide students into groups and designate each group a local tree with a base circumference of at least 50 cm.

Agree on a method for each group to distinguish their tree from the others in the area. This can be done by:

* using GPS coordinates.
* taking a photograph.
* drawing its distinguishing characteristics.

✎ STUDENT NOTES: Measure vertically up the trunk, 1.3 m from the base of the tree. This is the height at which you will measure the circumference of the tree. Measure the circumference of the tree (keeping the tape measure level) three times. Determine the average circumference of the tree.

(Slide 37) Use spreadsheet software to prepare a graph of ‘The circumference of the tree (cm)’ vs the ‘Tree’s dry weight (kg)’.

✎ STUDENT NOTES: Use the graph to determine the approximate biomass of the tree that was measured.

Discuss that scientists have tested a large number of trees from across Australia to find patterns and have determined that the tree biomass contains 50% carbon.

✎ STUDENT NOTES: Calculate the total carbon stored in the tree.

$$Total carbon \left(tonnes\right)=total biomass \left(tonnes\right) ×0.5$$

Discuss how carbon dioxide was taken from the atmosphere as part of photosynthesis.

**Potential discussion prompts**

* *How did the carbon get into the tree?*
* *Where did the tree carbon come from?*
* *I wonder how much carbon dioxide was taken from the atmosphere by your tree?*

✎ STUDENT NOTES: Calculate the amount of carbon dioxide that was removed from the atmosphere through photosynthesis as a result of the tree growing to its current size.

$$Carbon dioxide equivalent to biomass=total carbon \left(tonnes\right)×3.67$$

(Slide 38) Optional: Use an algorithm in the data spreadsheet to convert the graph to:

* Circumference of the tree vs Total carbon stored in tree.
* Circumference of the tree vs Carbon dioxide removed from the atmosphere.

## Integrate • Validating the results

(Slide 39) Discuss the results of students’ calculations.

**Potential discussion prompts**

* *Why was the circumference always measured at 1.3 m from the ground?*
* *Why was the circumference of the tree measured 3 times and averaged? How does this affect the accuracy of the results?*
* *How could we check that the tape measure was accurate? How would it affect our calculations if it was not accurate?*
* *What would be the largest tree we could measure using this result? Would our results be just as accurate if we used the graph to measure the carbon in a tree larger than 400 cm? Why or why not?*
	+ Extrapolating or extending a graph outside its intended purpose means it is inaccurate.
* *Do all trees grow at the same rate? How do you think that this could affect the calculations that we made?*
	+ These calculations assumed that all trees are the same. Some trees are denser than others and therefore may have more or less carbon stored in their biomass.
* *How could we improve the accuracy of these measurements? As students? As a scientist working in this area?*
	+ Students could increase the sample size of trees and make comparisons of tree trunks to the height of a tree. Scientists would compare the density of different tree types to compare the biomass stored in slices of a tree.
* *What assumptions have we made about this method? How do we know it is a valid test?*

Students should write their questions or comments about the validity of their results on sticky notes and place them in a location in the room.

Rearrange the notes into groups and discuss. Use the validity framework as a guide for possible groups:

* Question
* Repeatability
* Assumptions
* Sample size
* Accuracy
* Reliability
* Precision
* Limitations

✎ STUDENT NOTES: Record the factors that contribute to an investigation being valid.

**Potential discussion prompts**

* *Do you think this test is valid for all trees in Australia, and in all countries?*
	+ No. Not all trees are the same.
* *What does it mean for a test to be valid?*
	+ A valid test can be trusted. It must be repeatable, good sample size, be accurate, reliable, precise, and answer the question that was asked.
* *What assumptions have we made about this test?*
	+ The calculations provided by the ‘scientists’ are appropriate for the trees you measured.

(Slide 40) Discuss how biomass could affect the intensity of a bushfire.

**Potential discussion prompts**

* *Why is biomass important in bushfires?*
	+ Big trees have more biomass. Dried leaves and bark are also biomass. Biomass is a fuel in a bushfire.  More biomass means more fuel.
* *Why would small, light leaves and bark be the ‘best’ fuel for a fire?*
	+ They can mix with oxygen easily (like the flour in Lesson 2), thus helping the fire to burn.
* *Why do bushfires add to the carbon dioxide levels in the atmosphere in the short term?*
	+ Combustion produces carbon dioxide.
* *Why might increasing carbon dioxide levels be a bad thing?*
	+ Might contribute to climate change.
* *How could we reduce the number of bushfires?*
	+ This will be covered next lesson.

### Reflect on the lesson

You might:

* identify how the intensity of a bushfire is affected by different types of biomass.
* discuss how [computer vision and machine learning](https://www.tern.org.au/measuring-vegetation-status-by-photography/) could be used to determine the biomass of an area.
* re-examine the intended learning goals for the lesson and consider how they were achieved.
* discuss how students were thinking and working like scientists during the lesson.

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**Y9**

 Bushfire and ice • Lesson 5 • Ice core evidence

**Lesson 5**

**INQUIRE**

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| To read the most recent version of this lesson, download associated resources, and view embedded professional learning including classroom videos and work samples, visit: [https://scienceconnections.edu.au/teaching-sequences/year-9/bushfire-and-ice/lesson-5-ice-core-evidence](https://scienceconnections.edu.au/teaching-sequences/year-9/bushfire-and-ice/lesson-5-ice-core-evidence?utm_source=docx&utm_medium=lesson_5&utm_campaign=BI) |

# Lesson overview

Students analyse 800,000 years of carbon dioxide data and correlate this to changing global temperatures. Students examine how changes in greenhouse gases affect the likelihood of bushfires.

## Key learning goals

Students will:

* examine the data provided by ice cores.
* use data from Australian scientists to create a graph that ‘tells a story’.
* compare current atmospheric carbon dioxide levels to historical records.

Students will represent their understanding as they:

* create a representation of the age and carbon dioxide levels in an ice core.
* use data to generate graphic representations of changing carbon dioxide levels over 800,000 years.
* describe the difference between correlation and causation.
* use argumentation processes in discussions.

## Assessment advice

In this lesson, assessment is formative.

Feedback might focus on:

* analysing representations of data from ice cores to identify patterns and trends in the amount of carbon dioxide in the atmosphere, highlighting inconsistencies.
* argumentation that links claim and evidence through reasoning.
* explanations of how scientific knowledge is validated and refined, including the role of conferences and peer review.
* analysing and connecting data to identify and explain patterns and trends, relationships and anomalies.
* the validity of data when extrapolating from a graph.

**Potential summative assessment**

Students working at the achievement standard should:

* explain how scientific knowledge is validated and refined, including the role of publication and peer review.
* examine how the values and needs of society influence the focus of scientific research.
* be able to explain how interactions within and between Earth’s sphere affect the carbon cycle.
* select and construct appropriate representations to organise, process and summarise data and information.
* analyse and connect data and information to identify and explain patterns, trends, relationships, and anomalies.
* analyse the impact of assumptions and sources of error in methods and evaluate the validity of conclusions and claims.
* construct logical arguments based on evidence to support conclusions and evaluate claims.
* select and use content, language, and text features effectively to achieve their purpose when communicating their ideas, findings, and arguments to specific audiences.

Refer to the [Australian Curriculum content links on the Our design decisions tab](https://scienceconnections.edu.au/teaching-sequences/year-9/bushfire-and-ice?tabIndex=2) for further information.

## List of materials

**Whole class**

* **Bushfire and ice Resource PowerPoint**
* Access to internet and YouTube for videos on bushfires
* **Carbon cycle game Resource sheet**
* Optional: [114 years of Australian temperatures poster](http://www.bom.gov.au/climate/history/temperature/)from the Bureau of Meteorology

**Each group**

* Roll of paper (paper towel etc.) 2.15 m long, or graph paper 22 cm long
* Measuring tape or ruler
* Texta or permanent marker
* Sticky notes

**Each student**

* **Ice core Data resource**
* Spreadsheet software

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| **Lesson routine** | **Estimated time** | **Task type** |
| **Re-orient** | 5 minutes | Whole class |
| **Question** | 10 minutes | Whole class |
| **Investigate** | 30 minutes | Individual |
| **Integrate** | 20 minutes | Whole class/Individual |

# Inquire

## Re-orient

Recall:

* the four ‘spheres’ where carbon can be found.
* examples of carbon molecules that can be found in the atmosphere.

## Question • Atmospheric carbon dioxide

**Pose the question:** *Does it matter if atmospheric carbon dioxide levels change?*

Discuss recent media reports on the changes in climate as a result of increased carbon dioxide levels.

**Pose the question:** *Have atmospheric carbon dioxide levels always been the same?*

## Investigate • Ice core data

Refer to the **Carbon cycle game Resource sheet** to identify where atmospheric carbon dioxide could go—it can remain in the atmosphere, or move to the biosphere or hydrosphere.

(Slide 42) Discuss how carbon dioxide in the hydrosphere can be trapped when ice is formed in the Antarctic. This allows scientists to see how the levels of carbon have changed over time by drilling ice cores. An ice core is a column of ice about 15 cm wide. It has hundreds of layers of ice. The deeper you go, the older the ice.

Watch the video [What the Antarctic ice cores tell us about climate change (2:35)](https://www.youtube.com/watch?v=VjTsj-fi-p0).

Introduce the work of Dr Andrew Smith, a principal research scientist at ANSTO, who works with atmospheric scientists and glaciologists to measure the amount of radiocarbon that is trapped as carbon dioxide at two sites in the Antarctic ice. Some of his data on 800,000-year-old ice is available for students to use.

(Slide 43) Explain how students have access to real data gathered by Australian scientists that can be used to examine how carbon dioxide levels have changed over time.

Discuss how we know that this data is reliable.

**Potential discussion prompts**

* *Where do we get the data?*
	+ Made available through open source for all scientists around the world. This means it is checked before being used by other scientists.
* W*ho collects the ice cores? How do we know?*
	+ A group of scientists from different groups often collaborate for the expeditions. The data comes from multiple ice cores that are compared from different locations.
* *How do we know the ice cores are stored appropriately?*
	+ This is reported as part of submitting a peer-reviewed article that is published.

Optional: Discuss how radioactive elements (such as *beryllium-10, chlorine-36, and carbon-14*) can be used to determine the age of the ice or the gases caught in the ice.

**Making an ice core**

Provide students with the **Ice core Data resource**.

Explain that students will make a model ice core using a sample of data points taken from this data. Provide each group of students with a roll of paper at least 2.15 m long to represent the ice core (this looks effective when placed up a wall as a display). Alternatively, graph paper that is 22 cm long could be used, although the final measurements can be millimetres apart.

✎ STUDENT NOTES: Use the data to draw an ice core and describe where and how it is generated:

1. Select data from the ‘Making Ice Core’ tab at the base of the Excel spreadsheet.
2. Draw a line down the centre of the paper roll.
3. Mark one end of the paper roll as the closest to the surface level as the start of the ice core. This ice is from 1950 (T=0).
4. Label the left-hand side of the line ‘Years ago’.
5. Label the right-hand side of the paper ‘Carbon dioxide level [ppmv]’ (ppmv =concentration of parts per million in volume).
6. Measure the distance from the top of the ice core.
7. Record the age of the gas and the carbon dioxide level at each location on the paper roll.

(Slide 44) Discuss the data shown on the model ice core and how well the model represents the type of data used by scientists.

✎ STUDENT NOTES: Explain what the model shows and the limitations of this model.

**Potential discussion prompts**

* *What does the model ice core tell us about the levels of carbon dioxide over time?*
	+ The concentration of carbon dioxide varies between 180-300 ppmv.
* *Is the amount of ice identical for each time period?*
	+ No. Some decades/centuries there is more ice than others.
* *What could affect the amount of ice that forms each decade/century?*
	+ The amount of rainfall/snowfall, the temperatures.
* *How effective is this model in representing the carbon dioxide levels over time?*
	+ It helps to represent how the age of the ice (and trapped carbon dioxide) increases with depth.
* *What are the limitations of such a model?*
	+ It is very simplified and difficult to see the details of carbon dioxide change, it does not show all the data – only 350,000 years instead of 800,000 years.

**Optional:** Produce a large model of the ice core, to be placed on a wall of the science room.

**Graphing carbon dioxide data**

(Slide 45) Explain that graphs are another way to represent the data (how the carbon dioxide levels have varied over the last 800,000 years).

Divide groups of students according to their abilities and select the appropriate data tabs from **Ice core Data resource**.

**Adapt the data**

There are four sets of data provided as part of this activity.

**Making Ice Core:** a simplified set of data with 18 data points.

**Group A:** the complete set of data as provided by ANSTO scientists. It is an amalgamation of data from the EPICA (European Project for Ice Coring in Antarctica) Dome C ice core covering 0 to 800 kyr BP (thousand years before present). The different colours represent the different sets of data.

**Group B:** the complete set of data as provided by ANSTO scientists. It is broken into five separate ice cores (B1-B5) that together provide a complete picture of the last 800,000 years. This could be used for different groups of students playing the role of collaborating research labs. The data could be compared between the labs in a peer review process.

**Group C:** the pre-graphed data for those students who may have limited ability to use a computer or excel spreadsheets.

Guide the students through the process of creating a chart:

1. Select/highlight two columns ‘Age of the gas’ and ‘CO2 concentration’ columns in the tables.
2. Select ‘Insert’ and ‘Scatter Graph with smooth lines and markers’ in the ‘Charts’ section of the top ribbon of the Excel spreadsheet.
3. Select ‘Chart design’ from the top of the page.
4. Select ‘Add Chart Element’ from the LHS of the top ribbon to add a title for the graph and axis labels.

## Integrate • Making sense of the data

Ask students to describe how the carbon dioxide levels have increased and decreased over time, making reference to their graphs.

✎ STUDENT NOTES: Use argumentation processes to make claims about the data (claim, evidence, and reasoning that link everything together).

**Potential discussion prompts**

* *How does the carbon dioxide levels change over time?*
* *How many peaks in carbon dioxide levels have there been in the past 800,000 years?*
* *What might have caused more carbon to be released into the atmosphere in the past?*
	+ Warming oceans release carbon dioxide and decrease plant life due to rising water levels. See the embedded PL.
* *What is the lowest level of carbon dioxide shown in the graphs?*
* *What is the highest level shown in the graphs?*
* *Could we extrapolate the graph to predict what the current carbon dioxide level might be?*
	+ No. Extrapolating off a graph is not valid as it is outside the tested limits of the data. This point will be reinforced when examining cultural burning in Lesson 6.

Discuss how at conferences scientists will often display their results to discuss and compare inferences that are made as a result of data. Set up a gallery walk (similar to a simplistic poster display) where students examine each other's graphs and the argumentation processes that were made. Encourage students to identify any counterclaims that may be made.

**Potential discussion prompts**

* *Which group has the most recent data set (fewest years ago)?*
* *Which group has the oldest data set (most years ago)?*
* *Can we put them in order of youngest to oldest?*
* *Is the data consistent (do they show the same pattern)?*
* *Why do scientists need to review the data with their peers*?
	+ To check that their results are valid and consistent with the results found by others.
* *How is this usually done in science laboratories?*
	+ At conferences, or publishing peer-reviewed papers.

(Slide 47) Discuss the peer-reviewed graph that combines data from multiple sources.

✎ STUDENT NOTES: Describe the ‘story’ told by the data.

Compare the previous highest levels of carbon dioxide to the current level from [Cape Grim TAS](https://www.csiro.au/en/research/natural-environment/atmosphere/Latest-greenhouse-gas-data) or [Hawaii](https://www.co2.earth/daily-co2).

✎ STUDENT NOTES: Locate this value on your own graph (it is off the scale).

Discuss if this value is an anomaly (a single unusual event) or part of a pattern. Use the [values determined by CSIRO at Cape Grim](https://capegrim.csiro.au/) to identify that there has been a slow but significant increase over the last 40 years. The current carbon dioxide value is part of a larger pattern that has been peer-reviewed by scientists.

**Potential discussion prompts**

* *How do we know if the Cape Grim result is accurate?*
	+ It can be checked against other values for carbon dioxide. For example [NASA.](https://climate.nasa.gov/vital-signs/carbon-dioxide/?intent=121)
* *Using what we know about the fast and slow carbon cycle, what is the most likely cause of the high carbon dioxide level?*
	+ The carbon trapped in the slow cycle fossil fuel has been released into the atmosphere through combustion.
* *Is carbon dioxide the only greenhouse gas?*
	+ No. Water, methane, and other industrial gases (nitrous oxide and fluorocarbons) are greenhouse gases.
* *How is this affecting us?*
* *Why is it important to fund this research now? Why wasn’t it researched as much 50 years ago?*
	+ Less money was provided 50 years ago for this research as global warming wasn’t seen as a big enough problem then.

Optional: Show the students the [**114 years of Australian temperatures poster**](http://www.bom.gov.au/climate/history/temperature/)from the Bureau of Meteorology for more recent information on changing temperatures.

Optional: Discuss how some scientists are currently working to reduce the amount of carbon dioxide being produced or remove it from the atmosphere.

(Slide 48-49) Discuss the link between bushfires and carbon dioxide levels. Bushfires are combustion reactions that release carbon dioxide, but plants grow quickly after a bushfire, absorbing carbon dioxide. Over time, bushfires are expected to be carbon neutral.

**Potential discussion prompts**

* *Do bushfires increase the level of carbon dioxide in the atmosphere?*
	+ Bushfires temporarily increase the level of carbon dioxide levels in the air.
* *What does a bushfire area look like 1 year later, 5 years later, 10 years late?*
	+ Once an area has been cleared by fire, many plants grow quickly and take up large amounts of carbon dioxide from the atmosphere. Therefore, bushfires have no net effect on carbon dioxide levels. (Discuss the meaning of the term ‘net’.)
* *Do you think bushfires contribute to the overall carbon dioxide levels?*
	+ Bushfires do not contribute directly to global warming.

✎ STUDENT NOTES: Write your own conclusion about the impact of bushfires on carbon dioxide levels in the atmosphere.

In the following optional lesson, you can examine the link between carbon dioxide levels and global warming.

### Reflect on the lesson

You might:

* encourage students to examine how the greenhouse gases contribute to global warming through the simulation websites.
* encourage students to calculate their carbon footprint.
* re-examine the intended learning goals for the lesson and consider how they were achieved.
* discuss how students were thinking and working like scientists during the lesson.

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**Y9**

**Lesson 5A**

**INQUIRE**

Bushfire and ice • Lesson 5A • Correlating carbon dioxide levels and global temperatures

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| To read the most recent version of this lesson, download associated resources, and view embedded professional learning including classroom videos and work samples, visit: [https://scienceconnections.edu.au/teaching-sequences/year-9/bushfire-and-ice/lesson-5a-correlating-carbon-dioxide-levels-and-global-temperatures](https://scienceconnections.edu.au/teaching-sequences/year-9/bushfire-and-ice/lesson-5a-correlating-carbon-dioxide-levels-and-global-temperatures?utm_source=docx&utm_medium=lesson_5a&utm_campaign=BI) |

# Lesson overview

Students correlate variations in carbon dioxide levels in the atmosphere with global temperature variations.

## Key learning goals

Students will:

* examine ice core data that records the changes in global temperature over time.
* compare global temperature changes with global changes in carbon dioxide levels.

Students will represent their understanding as they:

* use argumentation to make claims about changes in global temperature over 800,000 years.
* outline the difference between correlation and causation.
* research the impacts of global climate change.

## Assessment advice

In this lesson, assessment is formative.

Feedback might focus on:

* the difference between correlation and causation.
* how different times scales can impact results.

**Potential summative assessment**

Students working at the achievement standard should:

* explain how scientific knowledge is validated and refined, including the role of publication and peer review.
* select and construct appropriate representations to organise, process and summarise data and information.
* analyse and connect data and information to identify and explain patterns, trends, relationships, and anomalies.
* analyse the impact of assumptions and sources of error in methods and evaluate the validity of conclusions and claims.
* construct logical arguments based on evidence to support conclusions and evaluate claims.
* select and use content, language, and text features effectively to achieve their purpose when communicating their ideas, findings, and arguments to specific audiences.

Refer to the[Australian Curriculum content links on the Our design decisions tab](https://scienceconnections.edu.au/teaching-sequences/year-9/bushfire-and-ice?tabIndex=2) for further information.

## List of materials

**Whole class**

* **Bushfire and ice Resource PowerPoint**

**Each student**

* Individual science notebook
* **Correlating CO2 levels with average temperature in the Antarctic ice core Resource sheet**

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| **Lesson routine** | **Estimated time** | **Task type** |
| **Re-orient** | 5 minutes | Whole class |
| **Question** | 10 minutes | Whole class |
| **Investigate** | 15 minutes | Small group/Individual |
| **Integrate** | 30 minutes | Whole class/small groups |

# Inquire

## Re-orient

Recall the stages in the carbon cycle where carbon can spend a lot of time (slow carbon cycle).

Discuss how industry uses fossil fuels that release carbon dioxide.

## Question • Climate vs weather

**Pose the question:** *What keeps carbon dioxide in the atmosphere? Why does it not fly off into space?*

 Discuss how Earth’s gravity keeps the gases in the atmosphere close to the Earth’s surface and that the gases act like a greenhouse, keeping the Earth warm.

 **Potential discussion prompts**

* *Why does the Earth have an atmosphere, while other planets do not?*
	+ The Earth has a gravitational force that keeps the atmosphere close. The first gases in our atmosphere came from volcanoes, and gravitational force kept them close. Other planets did not have enough gravitational force or did not produce and keep the gases produced.
* *Why is the atmosphere important?*
	+ It protects the surface of the Earth from the worst of the solar radiation from the Sun (the atmosphere reflects much of the radiation) and keeps us warm like a greenhouse.
* *What would happen if we did not have an atmosphere?*
	+ We would be similar to the Moon (which has little atmosphere) with a temperature range of -133℃ to 121℃.

Discuss the difference between weather (the day-to-day variation in temperature, sunlight, wind, and rain) and climate (average conditions over very long periods).

✎ STUDENT NOTES: Describe the difference between daily temperature (part of the weather) and the average monthly or yearly temperature (climate).

**Pose the question:** *How do carbon dioxide levels correlate with the changing climate of the Earth?*

## Investigate • Graphing average global temperatures

Discuss how the temperature on Earth has changed over time, including ice ages.

 **Potential discussion prompts**

* *Has the temperature of the Earth always been the same?*
	+ No. The Earth has experienced ice ages in the past.
* *Does anyone know when was the last ice age?*
	+ 11,700 years ago.
* *What do you think caused the increase and decrease in temperature in the past?*

**Pose the question:** *Is carbon dioxide to blame for the temperature variations?*

Encourage the use of argumentation (Claim, Evidence, Reasoning) to discuss the type of evidence we would need to claim that carbon dioxide levels were to blame for previous increases in global temperature.

NOTE: This is only a retrospective view of climate change. Emphasise that this is not a reflection of current change in climate.

**Potential discussion prompts**

* *What claims can be made about where the carbon dioxide would come from?*
	+ Use the carbon cycle to examine how carbon dioxide could have returned to the atmosphere.
* *Was there combustion of fuels 11,700 years ago?*
	+ Except for bushfires, no.
* *What evidence would we need to show that increasing carbon dioxide levels were the cause of global warming in the past?*
	+ The carbon dioxide levels would have to increase first, before the global temperatures increased.
* *Is this a reflection of what is happening now?*
	+ No. This would be extrapolating a graph. Past conditions do not always reflect current conditions.

 (Slide 50-51) Provide students with the **Correlating CO2 levels with average temperature in the Antarctic ice core Resource sheet.**

Allow students to examine the data and discuss their claims, evidence, and reasoning with their peers.

✎STUDENT NOTES: Allow time for students to complete the **Resource sheet**.

## Integrate • Correlation vs causation

(Slide 53) Describe how there is a clear correlation between the two graphs, but that the graphs do not prove causation (the graphs do not show that one factor causes the other).

**Potential discussion prompts**

* *What is the difference between correlation and causation?*
	+ Correlation is a measure of the size and direction of a relationship between two sets of data, and causation is when one event is the result of the other event.
* *Can you give an example of correlation that is not causation?*
	+ The number of shark attacks go up every time ice-cream sales go up—both happen in hot weather, but one does not cause the other.
* *How do we know when one event causes another event?*
	+ One event usually follows another. If one event is removed, then the other will also stop. Stopping ice-cream from being sold will not stop shark attacks.
* *What evidence do you have for your claim?*
* *From the carbon cycle game in Lesson 4, are there any possible causes of increased carbon dioxide levels?*

Remind students that the data used in this lesson came from ice cores that dated before 1950 when the use of fossil fuels had increased significantly.

Show students [**115 years of Australian temperatures**](http://www.bom.gov.au/climate/history/temperature/) for more recent information on changing temperatures. Hovering over a year will increase the size of that map.

(Slide 53-54) Discuss the differences between previous global warming events that took thousands of years, and the current global warming event that is occurring in 50-100 years.

Potential discussion prompts

* *What do the maps on the* **115 years of Australian temperatures** *chart show?*
	+ The yearly average temperature differences from the mean (which was calculated based on 1961-1990).
* *How do the first 10 years of average temperatures across Australia vary?*
	+ That there is variation each year with almost as many ‘colder’ years as ‘warmer’ years.
* *Compare the first row to the second and third row. Do we see any major differences?*
	+ Very little differences. Equal amounts of yellow and green.
* *If this is the mean, is this variation normal? What does ‘mean’ mean?*
	+ The mean is the average, which suggests that sometimes the temperatures shown on the map are above normal and sometimes are below normal.
* *Compare the average temperatures in Australia over the last 20 years (the last two rows). What do you notice?*
	+ There is far more yellow and red (and less green) indicating that most years are much warmer than pre-1990.
* *From the graph showing* Correlation between carbon dioxide levels and temperature in the Ice Core*, how long did it take for the previous global warming events to reach their peak?*
	+ Tens of thousands of years.
* *Did all the peaks take this long (tens of thousands of years) to increase the mean global temperature?*
	+ Yes. All of the previous global warming events took many thousands of years.
* *What was the date of the most recent values on our ice-core data? Was this value within the normal carbon dioxide range?*
	+ 137 years before 1950. Normal range, 280 [ppmv].
* *How quickly has the current average global temperature increased?*
	+ 150 years (10 times faster).

✎STUDENT NOTES: Describe how temperatures have increased from the ‘normal range’ or average year temperature in the last hundred years, not over thousands of years.

Watch the video: [Why reducing our carbon emissions matters (a little story about climate change) (3:32)](https://www.youtube.com/watch?v=rivf479bW8Q).

(Slide 55) Divide students into teams to research the impact of global warming. The depth of the research may vary depending on the time available. Areas they could research include changes in:

* the number of extreme heat days.
* rainfall patterns.
* number and severity of thunderstorms (including lightning that causes bushfires).
* the number and severity of drought, which makes the biomass more likely to burn easily.

Discuss the results of the students’ research and relate it to the impact on the number and severity of bushfires.

(Slide 56) Discuss how computer modelling can predict fire weather conditions in 2060 - showing increasing numbers of fire danger days.

✎STUDENT NOTES: Describe how computers can model trends in changing temperatures and the amount of fuel in an area that can indicate a greater risk of fires.

**Potential discussion prompts**

* *What is a computer model?*
* *What data would need to be put into a computer model of bushfires?*
	+ Temperature changes, fuel load in the area, number and severity of bushfires in the past, the type of fuel/plants in the area.
* *How does the type and amount of data affect the effectiveness of a computer model?*
	+ If there is not much data or variety of data, then the model is unreliable. The model needs to be tested over a number of years. This model has been tested and compared against other models.
* *What colour shows nothing will change?*
	+ Pale pink.
* *What colour shows there will be a greater risk of fires?*
	+ Dark red.
* *Which area shows the greatest increased risk of fires in the future?*
	+ North and north-west Australia.

**Optional:** Discuss how some scientists are currently working to reduce the amount of carbon dioxide being produced or remove it from the atmosphere. Discuss how this will be examined next lesson.

### Reflect on this lesson

You might:

* use a carbon footprint calculator to determine the amount of carbon that you release into the atmosphere each year.
* re-examine the intended learning goals for the lesson and consider how they were achieved.
* discuss how students were thinking and working like scientists during the lesson. Focus on the ability to analyse models and determine any correlation or causation.

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**Y9**

Bushfire and ice • Lesson 6 • Factors affecting the rate and intensity of bushfires

**Lesson 6**

**INQUIRE**

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| To read the most recent version of this lesson, download associated resources, and view embedded professional learning including classroom videos and work samples, visit: [https://scienceconnections.edu.au/teaching-sequences/year-9/bushfire-and-ice/lesson-6-factors-affecting-rate-and-intensity-bushfires](https://scienceconnections.edu.au/teaching-sequences/year-9/bushfire-and-ice/lesson-6-factors-affecting-rate-and-intensity-bushfires?utm_source=docx&utm_medium=lesson_6&utm_campaign=BI) |

# Lesson overview

Students use secondary data to identify the factors that affect the speed a fire travels. They apply their understanding to evaluate a fire with unknown conditions.

## Key learning goals

Students will:

* examine the importance of controlled conditions in bushfire research.
* learn how models can be used to support the fighting of fires and protecting lives.

Students will represent their understanding as they:

* measure the speed at which a fire travels.
* compare how different factors affect the rate at which a fire spreads.
* discuss the limitations of the models that they develop.

## Assessment advice

In this lesson, assessment is formative.

Feedback might focus on:

* explaining the different ways in which science and society are interconnected.
* selecting and constructing appropriate representations to organise, process and summarise data and information.
* analysing and connecting data and information to identify and explain patterns, trends, relationships, and anomalies.
* evaluating the validity of conclusions and claims.
* analysing methods and conclusions to identify facts or premises that are taken for granted to be true, and evaluate the reasonableness of those assumptions.
* constructing logical arguments based on evidence to support conclusions and evaluate claims.
* selecting and using content, language and text features effectively to achieve their purposes when communicating their ideas, findings and arguments to specific audiences.

**Potential summative assessment**

Students working at the achievement standard should:

* investigate how advances in technologies enable advances in science, and how science has contributed to developments in technologies and engineering.
* describe how they have addressed intercultural considerations when using secondary data.
* analyse the key factors that contribute to science knowledge and practices being adopted more broadly by society.
* select and construct appropriate representations to organise, process and summarise data and information.
* analyse and connect data and information to identify and explain patterns, trends, relationships, and anomalies.
* analyse the impact of assumptions and sources of error in methods and evaluate the validity of conclusions and claims.
* construct logical arguments based on evidence to support conclusions and evaluate claims.
* select and use content, language, and text features effectively to achieve their purpose when communicating their ideas, findings, and arguments to specific audiences.

Refer to the [Australian Curriculum content links on the Our design decisions tab](https://scienceconnections.edu.au/teaching-sequences/year-9/bushfire-and-ice?tabIndex=2) for further information

## List of materials

**Whole class**

* **Bushfire and ice Resource PowerPoint**
* Access to the internet and YouTube for videos on bushfires
* Bushfire data Answers sheet

**Each group**

* Rulers
* **CSIRO Spark bushfire data Resource**

**Each student**

* Individual science notebook
* **Modelling fire travel Resource sheet**

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| **Lesson routine** | **Estimated time** | **Task type** |
| **Re-orient** | 5 minutes | Whole class |
| **Integrate** | 10 minutes | Whole class |
| **Investigate** | 20 minutes | Small group |
| **Integrate** | 15 minutes | Small group/Whole class |
| **Integrate** | 25 minutes | Whole class |
| **Integrate** | 10 minutes | Whole class |

# Inquire

## Re-orient

Recall the previous lesson, focusing on:

* the combustion reaction.
* biomass as the fuel in a bushfire.
* how throwing another log on a fire (or blowing on a fire) can make it burn higher.

## Integrate • Fire risks

Discuss the risks of being caught in a fire (being aware of students’ prior experiences or anxieties).

Show the 360° video of a bushfire: [Video of crown fire during a prescribed burn in the New Jersey Pine Barrens 2019 (1:50)](https://www.nist.gov/feature-stories/eye-fire).

**Pose the question:** *How can we predict how a fire will behave?*

Watch the video [How to predict the spread of a bushfire with a ‘Pyrotron’ (5:08)](https://www.youtube.com/watch?v=Tt36dzs8faQ).

## Investigate • Fire behaviour

Brainstorm all the factors that might affect the way a fire behaves. Consider factors that might affect the intensity of the fire, or how fast it spread.

Ideas that might arise include:

* humidity
* topography (uphill)
* topography (downhill)
* cut or grazed grassland
* cultural burned burning
* prescribed/back burning

✎ STUDENT NOTES: Record the brainstorm ideas.

**Optional:** Demonstrate how the angle of fuel and flame interact:

* Light a match and hold it with the flame at the vertical top—the match burns slowly and can sometimes go out.
* Light a match and hold horizontally—the match will burn faster than a vertical match.
* Flames burn faster if the fuel is uphill (consider the placement of fingers when demonstrating this).

Discuss how there are multiple ways to measure how fast a fire can spread or in what direction.

 **Potential discussion prompts**

* *Why might it be important to measure how fast the fire is travelling or in which direction it will travel?*
* *How could firefighters or scientists measure how fast a fire is travelling?*
	+ Comparing the time and location that a fire reaches a particular point using people on the ground, planes, drones or satellite images.
* *How could firefighters or scientists measure which direction a fire is travelling?*
	+ Comparing the time and location that a fire reaches a particular point using people on the ground, planes, drones or satellite images.

 Divide the class into groups and provide each group with the **CSIRO Spark bushfire data resource.**

(Slide 59) Explain that each group will examine a set of data to look at a single factor that affects the spread of a fire over time and compare it to a controlled burn. Discuss as a class a way to consistently measure each fire and the rate of spread.

Students compare the photos and identify the two sets of data they will examine, one set under controlled conditions and one set with their varied factor:

* Control: Undisturbed grassland
	+ Test: Undisturbed grassland (humid)
	+ Test: Grazed/Cut grassland
	+ Test: Grassland burned 12 months prior
	+ Test: Undisturbed grassland (windy)
	+ Test: Undisturbed grassland (wind change 1)
	+ Test: Undisturbed grassland (wind change 2)
* Control: Eucalyptus bushland
	+ Test: Eucalyptus bushland (10° uphill)
	+ Test: Eucalyptus bushland (10° downhill)
	+ Test: Eucalyptus Bushland (recently burned)
	+ Test: Eucalyptus Bushland (windy)

NOTE: There are two sets of 'unknown data' that can be used as part of the optional extension at the end of this lesson.

Provide students with a copy of **Modelling fire travel Resource sheet**.

**Potential discussion points**

* *Where do you think the fires started? Where is the ignition point?*
* *What do you think the different lines on the graph represent?*
	+ Each coloured shape represents the location of the fire front at 30 minute intervals.
* *How could we measure how far the fire has spread from the ignition point in the first hour?*
	+ Measure from the ignition point to the fire front at the second shape (2 x 30 minutes = 1 hour).
* *How could we measure how far the fire has spread in the second hour?*
	+ Measure from the second fire front (1 hour) to the fourth fire front (2 hours).
* *How could we convert the distance measurement into a speed?*
	+ The scale of each map is different. A ruler is needed to measure the length of the scale. A ratio formula is used to convert the cm into km. (Slide 59)
* *How could we work out the direction of the fire spread?*
	+ The top of the page is due north. The right-hand side is due east. The approximate direction can be determined using this method. The exact directions can be measured using a protractor to determine the angle from north.

✎STUDENT NOTES: Measure the speed the fire travels with the altered factor and without their factor (the control).

## Integrate • Understanding fire

(Slide 61) Discuss/describe the rate of fire spread of the ‘control’ fire. There should be two sets, one of undisturbed grassland and one of undisturbed bushland.

**Potential discussion points**

* *There were only two types of controls (undisturbed grassland and undisturbed bushland). How did the measurements different groups make compare?*
* *Why might there be some slight differences between the measurements of the same set of data?*
	+ Parallax error – eye line not being directly over the ruler; inaccurate rulers; mistakes.
* *What could we use to be more accurate?*
	+ Some computer programs like the CSIRO Spark program have inbuild computer measurements that are more consistent – one person, one tool, and large sets of data over many years.
* *Why might scientists run a model multiple times for the same settings?*
	+ A larger sample size is used to check for anomalies.

Each group reports on how the behaviour of the fire changed in each of the conditions measured. They should provide their claim of how fire burns differently in the identified condition, the evidence that supports their claim, and reasoning that links the two. The **Bushfire data Answers sheet** provides suggested teacher answers.

✎STUDENT NOTES: Identify that:

* uphill topography burns faster—fuel that is uphill have the chance to dry out and therefore catches on fire quicker when the ignition is possible.
* downhill topography burns slower.
* humid environments burn slower—fuel needs to dry out before it can ignite.
* windy days provide more oxygen and burn faster—bushland disrupts the wind flow and is therefore slower than grassland.
* cut grassland burns less intensely and therefore burns slower.
* recent cultural burn means there is less dry fuel and therefore burns slower.
* older cultural burn means there is more regrowth, more fine fuel, burns faster.

Group the different conditions into three groups:

* topography (uphill, downhill)
* weather (humidity, wind)
* fuel (cultural burning and time since last burn)

(Slide 62) Explain that this is called the ‘Fire behaviour triangle’.

**Potential discussion prompts**

* *How does the topography affect a fire?*
	+ Uphill fires expose the next lot of fuel to heat which dries it out ready for quick combustion.
* *How does a humid day affect a fire?*
	+ Fuel needs to be dry to be able to ignite.
* *How does having a previous fire affect the next fire*?
	+ It depends on how recent the fire was. Recent previous fires reduce the amount of small light materials which means there is less ready fuel. If the fire was longer ago, then there is a lot of new fuel available to burn. (Slide 64-65)

Optional: (Slide 66) Provide students with a copy of the unknown bushfire conditions. These images show 2-3 different conditions in the same image. The background provides a hint of grassland or bushland. Measurement of the distance travelled by the fire fronts will allow students to identify changes in the topography, weather, or fuel.

## Integrate • Cultural burning

Describe the limitations of scientific models, including how information is limited by current data and understanding of the conditions. Current models are also backward-looking (based on previous data) and cannot reliably predict all future conditions.

**Potential discussion prompts**

* *What things are included in this bushfire model?*
	+ It is based on data from bushfires that have already occurred. It is only an approximation of what will happen.
* *What things are not included in this bushfire model?*
	+ New situations that might not have been recorded so far. For example, the impact of global warming and how plant growth might be affected.

Discuss how having a hot (prescribed) fire in the same area each year can change the environment. Use the example of burning a small patch of a local area every year and discuss how some of the bigger trees and other slow-growing plants would not have the chance to grow. Instead, fast-growing non-native plants (weeds) would grow.

**Potential discussion prompts**

* *Do all species grow back strongly after fire?*
	+ No. Some species grow back quickly, but others take a long time.
* *If a species takes a long time to grow, how would it be affected by regular (yearly) fires?*
	+ The species may not survive and could potentially become extinct.
* *How would regular fires change a landscape?*
	+ It may change the types of plants that grow in the area. Even fire-adapted plants need time to grow.
* *Is it practical to burn the same area every year? Why or why not?*
	+ Only fast-growing plants/weeds will survive and die back each year. This generates an even greater fuel load for fires in the future.

(Slide 67) Read the quote from Warren Foster, First Nations Elder of the Yuin people. Discuss what this might mean and how it is different from prescribed burning being to control/dominate the bushfire fuel. Introduce the term cultural burning (cultural practice use by First Nations peoples to improve the health of Country).

**Pose the question:** *What is cultural burning? How do we know it improves the health of Country?*

Discuss how some investigations use secondary data from previous records. Outline how to determine if the data is valid including identifying where the data came from, who produced it, why did they produce it, the sample size and the limitations.

Watch the video [Tiwi Carbon Study: fire management for greenhouse gas abatement on the Tiwi islands (9:22)](https://www.youtube.com/watch?v=3BrzOHxN_HU). This video was produced by local First Nations people from the Tiwi Islands during one of their regular cultural events.

✎STUDENT NOTES: Describe the importance of reducing how often ‘burns’ happen in the Tiwi islands.  Instead of one fire every 1-2 years, changing to one fire every 4-6 years results in four times more carbon in the soil.

**Potential discussion prompts**

* *How does the Tiwi islands’ environment compare to the local environment in your area? (Focus on the differences.)*
	+ Different environments have different types of plants that burn differently.
* *What does it mean to say the Tiwi Islanders treat fire as a gift instead of a threat?*
	+ Fire is used to replenish the environment and encourage growth.
* *Why might it be good for the environment for the burns to happen less often?*
	+ Less often means more carbon is stored in the plants and the soil is not damaged from hotter more frequent fires. one fire every 4-6 years means 4 times more carbon in soil and plants.
* *What do you think happens to the good bacteria and fungi in the soil during a fire?*
	+ It depends on the heat of the fire. A hot fire kills the bacterial and fungi in the soil. A cooler slower fire does much less damage.

## Integrate • Extrapolating cultural burning data

✎ STUDENT NOTES: Describe how there are many First Nations cultures across Australia and that we cannot extrapolate one type of cultural burn to the many different environments and communities on Country. (Slide 68)

**Potential discussion prompts**

* *How many different First Nations Peoples’ communities are there across Australia?*
	+ There are over 700 different First Nations Peoples’ communities across Australia.
* *Can we extrapolate what we know from the Tiwi Islanders to the rest of Australia?*
	+ All scientists need to be aware of assumptions such as taking data from one area and expanding/extrapolating it to another area.
* *Will other parts of Australia respond to cultural burning in the same way?*
	+ Just because Country responds to fire in this way in the Tiwi Islands does not mean it will respond in the same way in other parts of Australia.
* *Does this cultural burning practice apply to all parts of Australia?*
	+ Each community has some practices in common and many practices that are different.
* *Why can’t we use this practice in other parts of Australia?*
	+ The climate and weather in different parts of Australia can be very different. This changes the types of plants, animals, and biomass available.
* *Why would scientists want to work with First Nations Peoples when researching bushfires?*
	+ First Nations Peoples have lived in this environment for tens of thousands of years. The local People know the Country and how it will respond to a fire.

### Reflect on the lesson

You might:

* review the conditions that affect a bushfire.
* summarise the information in the following videos
	+ [Bushfire science | BTN High (7:34)](https://www.youtube.com/watch?v=_1pi0-d2BM4)
	+ [Bushfires: how can science prepare us (3:00)](https://www.science.org.au/curious/video/bushfires-how-can-science-prepare-us)
	+ [Understanding fire weather (2:58)](https://www.youtube.com/watch?v=Jt1PCnSiqQI)
* re-examine the intended learning goals for the lesson and consider how they were achieved.
* discuss how scientific models are limited by current knowledge and understanding of events.

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**Y9**

 Bushfire and ice • Lesson 7 • Design to survive

**Lesson 7**

**ACT**

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| To read the most recent version of this lesson, download associated resources, and view embedded professional learning including classroom videos and work samples, visit: [https://scienceconnections.edu.au/teaching-sequences/year-9/bushfire-and-ice/lesson-7-design-survive](https://scienceconnections.edu.au/teaching-sequences/year-9/bushfire-and-ice/lesson-7-design-survive?utm_source=docx&utm_medium=lesson_7&utm_campaign=BI) |

# Lesson overview

Students apply their understanding to design a fire action plan for a selected audience and/or present a local plan to reduce the level of carbon dioxide in the atmosphere.

## Key learning goals

Students will:

* discuss how different groups in the community are affected by bushfires.
* design a fire plan for a local community.
* review the movement of carbon through the Earth’s spheres.
* research ways to reduce a person's carbon footprint.

Students will represent their understanding as they:

* record the positive and negative aspects of shutting off a power supply in extreme weather events.
* prepare a fire action plan for an identified group in the community.
* prepare and present a plan to reduce the likelihood of bushfires by reducing the amount of carbon dioxide in the atmosphere.

## Assessment advice

In this lesson, assessment is summative.

Students working at the achievement standard should:

* be able to explain how interactions within and between Earth’s sphere affect the carbon cycle.
* describe how they have addressed intercultural considerations when using secondary data.
* select and construct appropriate representations to organise, process and summarise data and information.
* analyse and connect data and information to identify and explain patterns, trends, relationships, and anomalies.
* analyse the impact of assumptions and sources of error in methods and evaluate the validity of conclusions and claims.
* construct logical arguments based on evidence to support conclusions and evaluate claims.
* select and use content, language, and text features effectively to achieve their purpose when communicating their ideas, findings, and arguments to specific audiences.

Refer to the [Australian Curriculum content links on the Our design decisions tab](https://scienceconnections.edu.au/teaching-sequences/year-9/bushfire-and-ice?tabIndex=2) for further information.

## List of materials

**Whole class**

* Access to AV equipment and YouTube

**Each group**

* Access to laptops and software to prepare infographics or brochures

**Each student**

* Individual science notebooks or computers

|  |  |  |
| --- | --- | --- |
| **Lesson routine** | **Estimated time** | **Task type** |
| **Anchor** | 10 minutes | Whole class/Small group/Individual |
| **Connect** | 15 minutes | Whole class/Small group/Individual |
| **Design and Communicate** | 30-120 minutes | Small group/Individual |

# Act

## Anchor • Bushfire science

Revisit the key learning that was covered during this sequence, by drawing a mind map that links the key ideas:

* Combustion requires fuel, oxygen and an ignition point.
* Combustion products are carbon dioxide and water.
* Global warming is increasing the frequency of bushfires (ice core evidence).

The intensity of fire can be affected by topography, weather and fuel.

## Connect • Impact of bushfires

Revisit the T-diagrams students created in the Launch phase and discuss the impact of bushfires in the local regions.

**Potential discussion prompts**

* *How are people directly affected by bushfire?*
* *What are the indirect effects of bushfire on the community?*
* *What does our community currently know about bushfires and what to do in a bushfire event?*
* *Does anyone have a bushfire plan?*
* *Do holiday makers need a bushfire plan?*
* *Which local areas are most at risk?* Remind students of the topography and the fuel risk in the area.
* *Where could people go if a bushfire was threatening our area?*
* *How could we communicate this to locals and visitors?*

**Optional:** Discuss the approach used by areas in the US—shutting off the main power supply during high-risk weather. Watch the video [Public safety power shutoff: a tool of last resort (3:00)](https://www.youtube.com/watch?v=zMQXOEspnck&t=50s). Discuss the positive and negative aspects of this approach including who is affected and how they are affected.

## Design and Communicate • Action plan

Outline the two Act(ions) that students can use to communicate ways to reduce the impact and likelihood of a bushfire.

**Part A—Fire action plan**

Students need to prepare a fire action plan for themselves, members of their community, or visitors to the region.

**Research local resources**

Identify if the local fire authorities have resources provided for particular audiences that can be modified for a different audience.

**Define the audience**

Students should identify who could be their audience for the fire action plan. This may include:

* primary school students.
* their school peers.
* local businesses.
* older members of the community.
* community cultural groups.
* parents and their peers.
* visitors to the area.

Identify where their audience will see this information. Where will they visit? What information style will the audience use/see?

Identify what form of the fire action plan would be most appropriate for their audience:

* Persuasive texts
* Infographics
* Video presentation
* Brochures
* Storybook
* Advertisements
* News broadcast
* Website page
* Public education campaign
* Local environment plan

Identify the information that should be included in the student’s fire action plan that allows them to show what they have learned in this teaching sequence.

This may include explanations of:

* What is a bushfire?
	+ Combustion reactions.
* How will bushfires behave in the local area?
	+ Consider the biomass in the local environment, local climate, and when the risk is higher than usual.
* What to do in the event of a bushfire.
	+ Students should investigate any plans made by the local council and community groups.
* Who to contact for more information.

**Part B—Local carbon plan**

Students need to plan a way to reduce carbon dioxide levels in the atmosphere and therefore reduce the likelihood of bushfires in the future and present this to a particular audience (that could include peers, school leaders, or local government representatives).

Students use a carbon footprint calculator to determine the base levels of carbon that they currently contribute to the atmosphere. This can be repeated several times with students modifying their activities in the lifestyle to measure how much they can reduce their carbon footprint.

Students’ presentations could:

* provide evidence of how carbon dioxide levels have changed over time.
* discuss the greenhouse effect and how it supports life on Earth.
* use the carbon cycle to describe factors that are contributing to the increased levels of carbon dioxide.
* describe at least two ways that atmospheric carbon dioxide levels could be reduced and how much this would make a difference.
* describe one way that the local community could contribute to the reduction in carbon dioxide levels and the potential impact of this in reducing the level of carbon dioxide in the atmosphere.

### Reflect on this lesson

You might:

* consider the role of science communicators in informing the public of atmospheric carbon dioxide levels.
* develop individual bushfire plans.
* develop ways to reduce individual carbon footprints.