



CO₂ Experiment - The Greenhouse Effect

Summary

Students conduct a simple experiment to make carbon dioxide. They identify human activities that change CO₂ levels, including travel choices, plus set goals to reduce their emissions.

See links to Western Australian Curriculum at end of this lesson plan.

Year level: Years 4 – 6
Teaching and learning resource.

Learning outcomes

Students will be able to:

- Conduct a science experiment and cooperate with group members;
- Understand that the Earth acts like a greenhouse to retain heat;
- Understand that CO₂ is an important greenhouse gas that maintains a temperature on Earth that allows plants and animals to survive;
- Recognise that an increase in CO₂ emissions impacts on the amount of carbon dioxide in the atmosphere, increasing average global temperatures;
- Identify human activities that increase or decrease CO₂ emissions;
- Understand how to reduce personal greenhouse gas emissions (especially transport related) and understand the personal benefits of doing this; and
- Set goals to reduce personal greenhouse gas emissions (especially transport related).

Resources

Technology Resources

Interactive whiteboard, projector and access to the internet to view animation at:
<https://archive.epa.gov/climatechange/kids/basics/today/greenhouse-effect.html>



Other Resources

For a class of 30 students:

- 5 plastic bottles, 5 balloons, 600 ml vinegar
- 10 teaspoons of bicarbonate soda
- Scribe area e.g. butchers paper, computer canvas or 30 Student Worksheets.

Background

We know that the average passenger vehicle emits about four tonnes of Carbon Dioxide (CO₂) each year¹, whilst walking and cycling emits none. But what is CO₂ and why is it important?

CO₂ is a colourless gas with a faint odour and a sour taste. As it is a minor component of Earth's atmosphere we cannot detect its scent in the air around us. We may not be able to see, touch, smell or taste it but it is an extremely important atmospheric gas and vital for our survival on Earth.

CO₂ is the most important gas for controlling Earth's temperature, playing a major role in the greenhouse effect and keeping the Earth at a temperature where living organisms can grow and survive. CO₂ is found just about everywhere. It is exhaled from our lungs and is a by-product of cellular function, it is used in fire extinguishers to displace the oxygen that fuels fire. It provides the bubbles in your cool drink and helps your baked goods rise.

Human activities such as driving vehicles, clearing land and burning fossil fuels (including coal, oil and gas) can lead to an abundance of CO₂ being released into the atmosphere². About half of our global CO₂ emissions are currently absorbed by the natural 'carbon sinks' in oceans and on land, the other half remains in the atmosphere and is responsible for much of the greenhouse effect and global warming³.

CO₂ has increased in the atmosphere from around 280 parts per million (ppm) to approximately 395ppm today — a 43 per cent increase from pre-industrial (1750) concentrations⁴. Although CO₂ comprises only 0.036 per cent of the air, its warming effect is significant⁵.

Travel to school represents 18.4 per cent of morning peak transport trips in Perth's metropolitan area, making a substantial contribution to congestion. That includes approximately 250,000 trips each weekday and more than a million vehicle kilometres travelled daily — with the associated impact of increased emissions⁶.

Air pollution as a consequence of traffic congestion around schools is affecting children and creating a "considerable" health concern⁷.

¹ Carbon Neutral carbon calculator - <http://www.carbonneutral.com.au/carbon-calculator/vehicles-and-fuel-use.html>

² <http://www.climatechange.gov.au/climate-change/climate-science/understanding-climate-change>

³ State of the Climate 2014, Bureau of Meteorology and CSIRO

⁴ Climate.gov - Climate Change: Atmospheric Carbon Dioxide - <https://www.climate.gov/news-features/understanding-climate/climate-change-atmospheric-carbon-dioxide>

⁵ <http://www.scientificamerican.com/article/if-carbon-dioxide-makes-u/> Pieter Tans, Senior Scientist, National Oceanic and Atmospheric Administration (NOAA) Earth System Research Laboratory

⁶ RACWA – Rethinking the school drop-off – 2024 - <https://rac.com.au/car-motoring/info/school-traffic-congestion>

⁷ The congestion-busting change that would transform school pick-ups – The Age 2023 - <https://www.theage.com.au/national/victoria/the-congestion-busting-change-that-would-transform-school-pick-ups>

Teaching and learning ideas

Teachers are encouraged to use a range of the teaching and learning ideas provided. The teaching and learning ideas provide opportunities to address multiple learning areas. Teachers can modify and extend ideas for different year levels and phases of schooling. Teaching ideas have been aligned to the Western Australian curriculum including identification of learning area, strand and sub-strand.

Activity 1 – What is carbon dioxide?

Explanation of experiment

When vinegar and baking soda mix together, there is a fast chemical reaction. There are several products of the reaction, although it is the CO₂ gas that fills the balloon. As vinegar is a weak acid and baking soda is a weak base, an acid-base reaction occurs where chemicals react to create new products. The carbonic acid breaks down into water and carbon dioxide in the form of a gas. This is released from the bicarbonate soda as an invisible gas. CO₂ is colourless and odourless and even though we cannot see it in the air it is taking up space in the balloon and it has weight.

Ask the students:

Q - “What is carbon dioxide and where does it come from?”

Get them to brainstorm their ideas with a partner or small group.

Explain to the students that although we can't see, taste, smell or feel CO₂ it is in fact vital for life on Earth, keeping the Earth at a temperature where living organisms can grow and survive.

- CO₂ is a naturally occurring gas that is essential for life on Earth.
- It comes from natural activities like animal and plant respiration, volcanic eruptions and thawing permafrost.
- It also comes from human activities like driving vehicles, clearing land and burning fossil fuels including coal, oil and gas.

Task - Students locate, generate and access data and information regarding why CO₂ is vital for life using search engines and simple search functions and classify information in meaningful ways.

Small group task

Ask students to get back in their pairs or small groups and summarise their findings of the tasks above.

- Each group is to find a creative way to explain, demonstrate or reveal their findings. This could incorporate use of digital media, visual media or an oral presentation.
- Identify current understandings, consider possible misconceptions and identify personal views on a topic (e.g. KWL chart, concept map).

As a class collate all ideas that each pair/group generated. Add any ideas the students have missed.

Co₂ experiment

We can't use our senses to detect CO₂ but we can trap it in a simple experiment.

Demonstrate the experiment shown below, then split the class back into their small groups so that they can conduct the experiment themselves.



Pour vinegar into plastic bottle about one quarter full.



Put two teaspoons of bi-carb soda into a balloon.



Place the balloon over the lip of the bottle.



Tip the contents of the balloon into the bottle.



Observe!

Give each student a Student Worksheet and ask them to complete the Activity 1 question.

Activity 1: Question

Q - Write a few sentences to describe what you observed during the experiment using these words: balloon, liquid, solid, gas, filled, bubbles.

Activity 2: Carbon dioxide and the 'Greenhouse Effect'

Explain to students that CO₂ is called a greenhouse gas. Show students a picture of a greenhouse.

Ask students

Q - What does a greenhouse do?

(Greenhouses are used for growing plants as they allow sunlight in but prevent heat from escaping)

Explain to students that our atmosphere (layer of gases around the Earth) acts like a greenhouse and traps heat at the surface of the Earth.

To help explain this, show your students this animation:

<https://archive.epa.gov/climatechange/kids/basics/today/greenhouse-effect.html>

When the students have viewed the animation ask them to answer the Activity 2 questions on the student worksheet.

Activity 2: Questions

1. What happens to the sunlight that reaches the Earth? (Some energy is absorbed by land and water, some is reflected)
2. The Earth’s surface warms up and gives off energy. Some of this is trapped by what? (Greenhouse gases, i.e. carbon dioxide)
3. How do humans add extra greenhouse gases to our atmosphere? (Driving a car, using electricity from fossil fuels like oil coal and gas, agriculture, trucks and planes)
4. What happens to the Earth’s temperature when humans release large amounts of greenhouse gases into the atmosphere? (Earth warms up)
5. How does a warmer Earth affect the planet? (Changing rain and snow patterns, melting glaciers, rising sea levels, drought i.e. climate changes)
6. Now show the video again and discuss the answers to these questions with your students.

Activity 3: Making the link

Ensure students have watched the animation in Activity 2:

<https://archive.epa.gov/climatechange/kids/basics/today/greenhouse-effect.html>

Split the class into six groups of five and ask students to look at Activity 3 on their Student Worksheet. Ask groups to brainstorm answers to these three questions, focusing on their personal lives, then write down answers (See possible answers below, or refer to the AuSSI-WA website for more ideas).

Column A	Column B	Column C
How do I contribute carbon dioxide to the atmosphere?	How can I reduce the amount of Carbon Dioxide I release?	What are some benefits of this change to my family and me?
I come to school by car	Walk or ride to school	Increased fitness, fun
I have long hot showers	Reduce my time in the shower	Reduce electricity bill
I leave lights and computer on	Turn off lights when not in use	Reduce electricity bill
I use a heater when it’s cold	Wear a jumper and socks	Reduce electricity or gas bill

Discussion

As a class discuss and expand on student answers.

- Ask students to choose one action from Column B that they are able to commit to within the next week e.g. “I will walk to school on Monday and Wednesday next week”. Ask students to complete the goal- setting template on their Student Worksheet.

- Still using their Student Worksheet, instruct students to create, draw, construct or generate an image of their chosen action (Column B) and the matching benefit (Column C). This will help students visualise the links.
- Some examples of the benefits of walking and riding to school include:
 - reduced air pollution around school;
 - feel empowered to 'play your part' in reducing CO₂ emissions;
 - improved fitness and health from exercise;
 - spend quality time with Mum on the way to school/from school;
 - streets 'feel' safer as there are less cars and more 'eyes on the street';
 - greater independence;
 - get to know and connect with the local neighbourhood;
 - a great excuse to walk the dog; and
 - no more car sickness!

You could display the answers, goals and images as a mural on the classroom wall or create an at home activity that involves their family. Family discussions and contributions as to how the family unit can potentially reduce the amount of carbon dioxide they produce.

Choose active travel

Active travel is focused on physical activity such as cycling and walking instead of using motorised vehicles with CO₂ emissions. Active travel can reduce environmental, social and economic impacts.

Incorporating active travel such as walking and cycling to your daily trips is key in tackling air pollution and protecting the environment. Being physically active has numerous health benefits and can save you money too.

Small group task

Design an action-based learning activity aimed at reducing greenhouse gas pollution by using active travel more often instead of the car.

Your planning document should include:

- Context;
- Purpose;
- Background;
- Sustainability action planning;
- Key Elements Rubrics (KER);
- Ecological Footprint*;
- Social Handprint* and
- Evaluation.

Extension activities

Much of the vocabulary introduced in the activities above may be new to the students.

Ask students to write a list of all the new words they have learnt during these activities and write a definition for each one as a homework or assignment task.

One week after students have written their goals, hold a class discussion to reflect on their ability to commit to their goal. Were they able to commit? Why or why not? What barriers did they come across during the week? Is it an action they can continue with?

Follow up with the [Local Transport, Global Impact classroom activity](#)

Small group task

Each group is to choose a theme and then research positive change ideas with the aim to reduce carbon dioxide and/or promote active transport.

Possible themes:

- Change your travel habits for the environment;
- Redesign your street for people (as a way to encourage people to use active transport);
- Ways to make your street greener and safer;
- Organise a street library;
- Bring nature home by introducing plants and trees into your street;
- Hold a community event;
- How to organise a street party;
- Encourage residents to drive less and
- Street seats as a way to encourage people to be outdoors and enjoy the environment.

Group questions

(Questions designed for secondary students - Year 10 alignment to Western Australian Curriculum).

- Outline the natural resources (e.g. water, timber, minerals) provided by the environment and different views on how they can be used sustainably for your chosen theme.
- Locate and collect information and/or data from a range of appropriate primary sources and secondary sources (e.g. museums, media, library catalogues, interviews, internet).
- Record selected information and/or data using a variety of methods (e.g. use graphic organisers, paraphrase, summarise).
- Use decision-making processes (e.g. share opinions and personal perspectives, consider different points of view, identify issues, develop possible solutions, plan for action, identify advantages and disadvantages of different options).

Environmental change and management

Display the following question:

Q. What are the human-induced environmental changes that challenge sustainability (e.g. water and atmospheric pollution, degradation of land, inland and coastal aquatic environments)?

Discuss some of the environmental worldviews of people and their implications for environmental management.

Select one of the following types of environments as the context for a comparative study of an environmental change for Australia and one other country:

- Land;
- Inland water;
- Coast;
- Marine and
- Urban.

The causes and likely consequences of the environmental change being investigated.

Develop strategies to manage the environmental change being investigated.

How would you evaluate management responses to the change being investigated?

Assessment ideas

Using the answers on each student’s Worksheet, assess their ability to:

- Describe what they observed during the CO2 experiment (activity 1);
- Describe what they observed and learnt during the climate change animation (activity 2);
- Contribute to the team brainstorm, identify actions and associated benefits (activity 3) and
- Set a goal to commit to within the next week and draw a picture of the goal (activity 3).

Links to the Western Australian Curriculum

Table 1: Science

Strand	Sub-strand
Science understanding	<ul style="list-style-type: none"> • Biological sciences • Earth and space sciences
Science as a human endeavour	<ul style="list-style-type: none"> • Nature and development of science • Use and influence of science
Science inquiry skills	<ul style="list-style-type: none"> • Processing and analysing data and information • Evaluating

Table 2: Humanities and Social Sciences

Strand	Sub-strand
Geographical knowledge and understanding	<ul style="list-style-type: none"> • The Earth’s environment sustains all life (year 4) • Factors that shape the human and environmental characteristics of places (year 5) • Environmental change and management (Year 10)
Humanities and Social Sciences skills	<ul style="list-style-type: none"> • Questioning and Researching • Evaluating • Analysing
Skills	<ul style="list-style-type: none"> • Questioning and Researching • Communicating and Reflecting • Analysing • Evaluating

Table 3: English

Strand	Sub-strand
Language	<ul style="list-style-type: none"> • Expressing and developing ideas Vocabulary
Literacy	<ul style="list-style-type: none"> • Interacting with others Listening and speaking interactions • Interpreting, analysing, evaluating Analysing and evaluating texts • Creating texts

General capabilities

- Information and communication technology (ICT) capability, Literacy,
- Critical and creative thinking, personal and social capability, Ethical understanding.

Cross-curriculum priorities

- Sustainability

Cross-curriculum links

- Visual Arts, English

Weblinks

<https://www.csiro.au/en/Research/OandA/Areas/Assessing-our-climate/Climate-Science-Centre> - Detailed website with information on understanding climate change and reducing greenhouse gas emissions.

<https://www.science.org.au/publications/science-climate-change-questions-and-answers> - The Science of Climate Change Questions and Answers by Australian Academy of Science.

<https://archive.epa.gov/climatechange/kids/basics/today/greenhouse-effect.html> - A students' guide to global climate change, created by the United States Environmental Protection Agency.

http://www.coolaustralia.org/ca_topic/climate-change-2/ - detailed lesson plans on climate change and greenhouse gas emissions.

<http://www.det.wa.edu.au/curriculumsupport/sustainableschools/detcms/portal/> - AuSSI-WA has more ideas for reducing personal CO2 emissions. The website provides a whole-school planning framework for Education for Sustainability that has been developed 'by schools, for schools' with support from agencies.

Student Worksheet

Activity 1 – What is Carbon Dioxide?

Name _____

Write a few sentences to describe what you observed during the experiment using these words:
balloon, liquid, solid, gas, filled, bubbles

Activity 2 – Carbon Dioxide and the Greenhouse Effect

1. What happens to the sunlight that reaches the Earth?

2. The Earth's surface warms up and gives off energy. Some of this is trapped by what?

3. How do humans add extra greenhouse gases (such as carbon dioxide) to our atmosphere?

4. What happens to the Earth's temperature when humans release large amounts of greenhouse gases into the atmosphere?

5. How does a warmer Earth affect the planet?

Activity 3 – Making the Link

1. Brainstorm answers to these questions with your group, focusing on your personal life, then complete the table.

Column A	Column B	Column C
<p>How do I contribute carbon dioxide to the atmosphere?</p>	<p>How can I reduce the amount of Carbon Dioxide I release?</p>	<p>What are some benefits of this change to my family and me?</p>

2. Choose one action from Column B that you can commit to this week, and then complete the following.

<p>My goal this week is to:</p>

I want to achieve this goal because:

3. Draw an image of your chosen action (Column B) and its matching benefit (Column C).

Action



Result