# Carbon Capture & Storage - Resouces

Thank you for donwloading this Carbon Capture & Storage resource from the *GeoBus* website.

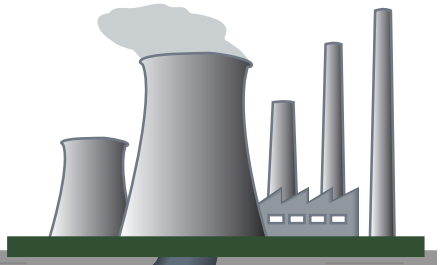
This resource pack was developed in partnership with The Crown Estate, with support from The Global CCS Institute, Royal Dutch Shell and SCCS. Special thanks are due to Megan O'Donnell and Katy Relph for their involvement. These resources, and further carbon capture and storage education materials can be found on the CO2 degrees challenge website.

The development of this resource would not have been possible without the generous support of the *GeoBus* sponsors, which we gratefully acknowledge.

University of St Andrews

Earth & Environmental Sciences

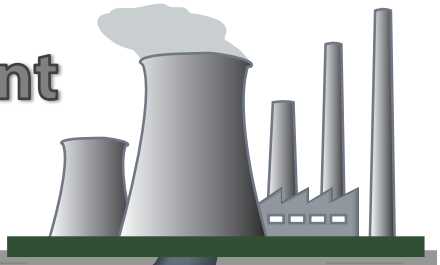
Chapter 1



# 1. Calculating Your Carbon Footprint

# Calculating Your Carbon Footprint

# Teacher Notes



| | |
|---|---|
| Activity Description | Students learn about $CO_2$ emissions, what a carbon footprint is and calculate their individual carbon footprint. They consider how behavioural changes could reduce their carbon footprint. |
| Time | 20mins / 40mins |
| Learning Outcomes | • To understand where carbon emissions come from<br>• To define a carbon footprint<br>• To ascertain ways in which lifestyle changes can affect your carbon footprint |
| Student Organisation | Individual (calculation) and Groups (discussion) |
| Materials Needed | Calculating Your Carbon Footprint; Student Worksheet and My Energy Diary |

**Talking Points**

How much electricity do you think you use? How often do you travel by car? Do you travel by aeroplane? Do you eat lots of red meat or imported fruits?

**Homework Task**

Ask the students to take home the Student Worksheet and My Energy Diary and fill them in over a period of a week.

**What is a Carbon Footprint?**

A measure of $CO_2$ emissions attributed to an individual/family/business based on their lifestyle and behavioural choices.

**Classroom Activity**

In a following lesson use the worksheet answers to complete the carbon footprint calculator online at:
*http://mothersagainstclimatechange.com/kidscarboncalculator.php*

Ask the children in turn to read out their total carbon footprint values and create a scatter graph to show the class results (either using Excel or by hand).

**Talking Points**

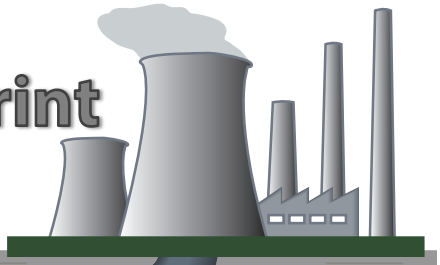
What kind of behaviour affects your carbon footprint? What could you be doing to reduce yours? What could the school be doing to reduce theirs?

**Tip!**

Ask the students to leave the first question on the worksheet blank. To determine the distance from the school to each student's house they can measure the distance on Google Maps during the classroom activity. This activity, the graphing exercise plus further discussion will extend the 20 minute session to 40 minutes.

# Calculating Your Carbon Footprint

## Student Worksheet



What is a carbon footprint?

_____

_____

_____

_____

You are going to calculate your carbon footprint using an online calculator.

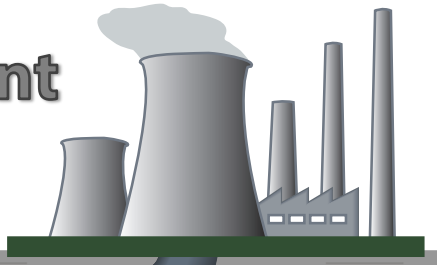
In order to complete the calculator next lesson you need to find out the following:

(use estimates if necessary)

1. How far is your house from the school? _____ km
2. How many hours a day do you spend watching TV? _____ hours
3. How many hours a day do you spend on the computer? _____ hours
4. How many light bulbs are there in your bedroom? _____ bulbs
5. What is the wattage of the bulbs in your house? _____ watts
6. How many hours do you leave your lights on in summer? _____ hours
7. How many hours do you leave your lights on in winter? _____ hours

# Calculating Your Carbon Footprint

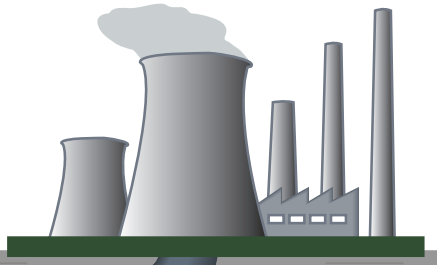
## My Energy Diary



Make a note of the following activities for a week to give you an idea of how much energy you are using. Base this on your individual usage.

| Day/Energy | Mon | Tues | Wed | Thu | Fri | Sat | Sun |
|---|---|---|---|---|---|---|---|
| TV (hours) | | | | | | | |
| Computer (hours) | | | | | | | |
| Mobile Phone (# of charges) | | | | | | | |
| Microwave (# of uses) | | | | | | | |
| Lights (hours) | | | | | | | |
| Car Journeys (hours and minutes) | | | | | | | |
| Showers (minutes) | | | | | | | |
| Hairdryer / Straighteners (minutes) | | | | | | | |
| Games Console e.g. Playstation / Xbox (hours) | | | | | | | |
| Other (hours) | | | | | | | |

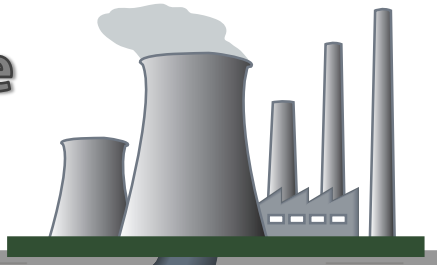
Chapter 1



# 2. Energy, Fuel and Climate Change

# Energy, Fuel and Climate Change

# Teacher Notes



| | |
|---|---|
| Activity Description | The students will learn about energy, where it comes from and consider the consequences of our current energy consumption. They will understand the implications of using fossil fuels for the environment and they will be introduced to CCS in this context. |
| Time | 1 hour |
| Learning Outcomes | • To understand what energy is<br>• To know where electrical energy comes from<br>• To understand the implications of fossil fuels for the environment<br>• To consider carbon CCS as a $CO_2$ remediation solution |
| Student Organisation | Individual |
| Materials Needed | Energy, Fuel and Climate Change Student Worksheet<br>Make Your Own Power Station Experiment resources (see below) |

**Talking Point**

What do you think energy is?

Is the energy you use to swim, run, and dance the same as the energy used by the TV and the microwave?

**Energy Facts:**

Energy has lots of different forms.

Energy cannot be created or destroyed, it can only be transferred from one type to another. For example, energy eaten as food is transferred to kinetic energy and energy stored in coal is transferred to heat energy.

**Fuel Facts**

The energy we use to generate electricity can be created in many ways; most commonly in the UK we burn fossil fuels. Fossil fuels include coal, oil or gas. They form when organic matter such as plants, trees, and animals die and are rapidly buried under many layers of rocks.

Fossil fuels take millions of years to form. When we take them out of the ground and burn them we rapidly release energy they have been storing for that time. Fossil fuels are an **unsustainable** energy source – we use them faster than they can replenish themselves. **Sustainabl**e energy sources cannot be exhausted and readily replenish themselves.

**Talking Point**

Can you think of any problems we might have if we only use sustainable sources of energy?

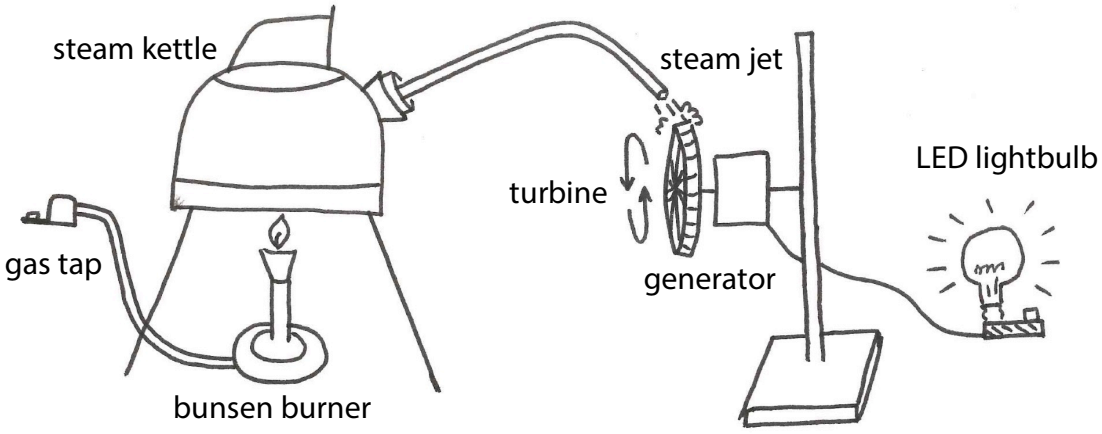
# Energy, Fuel and Climate Change
# Teacher Notes

Hint: Energy companies choose to burn fossil fuels at times when electricity is in high demand. What happens on a wind farm when it is windy, but our demand for energy is not as high?

**Classroom Activity**
**Make Your Own Power Station Experiment**

**You will need:**

- Bunsen burner
- Steam kettle on a stand
- Cork stop for kettle
- Pipe to direct steam
- Turbine
- Generator
- LED lightbulb and connector cable

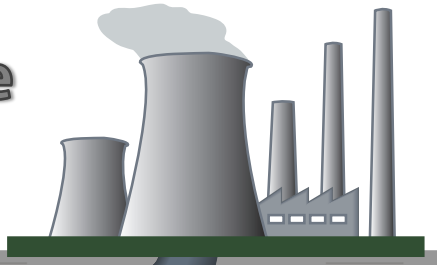



This experiment illustrates how power is generated in power stations. It also requires the students to think about scale. LEDs require a very small amount of energy to run. Ask the students to imagine the scale at which a power station supplying 500,000 homes must operate.

**Talking point:**
A byproduct of burning fuels is waste $CO_2$ gas. $CO_2$ contributes to the greenhouse effect and prevents the suns rays escaping from our atmosphere, consequently warming the planet. If we want to continue to use fossil fuels we must find a way of dealing with $CO_2$.

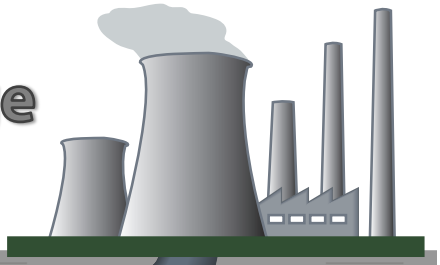
# Energy, Fuel and Climate Change

# Student Worksheet



Draw three things that use different types of energy. Write down the type of energy in the system and if the energy has changed from one state to another. *e.g. heat to light, electrical to heat, etc.*

# Energy, Fuel and Climate Change
# Student Worksheet

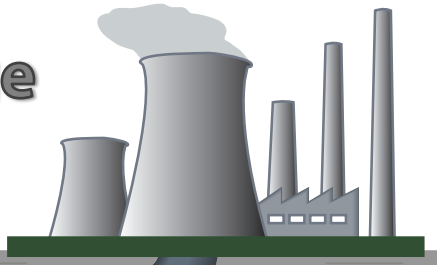


Where does electrical energy come from?

Draw and name three sustainable energy sources.

What problems might we have if we only used sustainable forms of energy?

# Energy, Fuel and Climate Change
# Student Worksheet



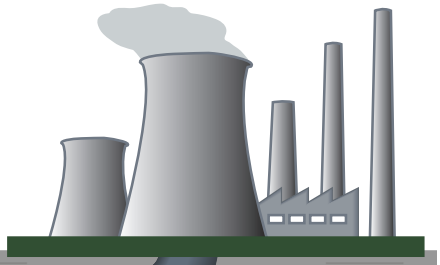
Draw a sketch of your power station in the box below and label each component.

With a coloured pencil, label each energy change in the experiment.
e.g. potential energy (*fuel*) -> light + heat energy (*flame*)

In the boxes below, brainstorm the advantages and disadvantages of renewable and non-renewable energy types.

| **Advantages of Renewable Energy** | **Advantages of Fossil Fuels** |
|---|---|
| | |
| **Disadvantages of Renewable Energy** | **Disadvantages of Fossil Fuels** |
| | |

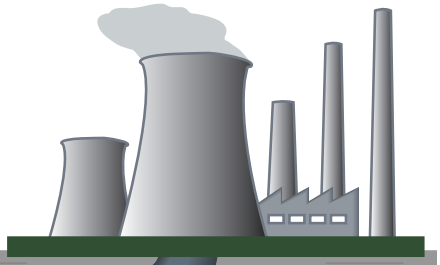
# Chapter 1



# 3. The Carbon Cycle

# The Carbon Cycle

## Teacher Notes



| | |
|---|---|
| Activity Description | The students will learn about carbon, the carbon cycle, $CO_2$ emissio their environmental significance and the role of CCS in this system. |
| Time | 1–2 hour(s) |
| Learning Outcomes | • To understand the basic chemistry of carbon<br>• To understand the carbon cycle and its components<br>• To understand the imbalance within the carbon cycle due to CC emissions |
| Student Organisation | Individual / Groups / Class |
| Materials Needed | Carbon Cycle Student Worksheet, Enhanced Oil Recovery Experime resources (see below), Carbon Cycle Printable Resources |

### Key Facts

Carbon is a chemical element with the symbol **C**. Carbon can come in the form of **graphite**, the material in your pencils; **diamonds**, very old and compressed carbon from the ground; or **coal/soot**, the precursor/product of organic combustion. Carbon is the fourth most abundant element in the universe. It is present in all living things and, second to oxygen, you are made of mostly carbon!

The amount of carbon on earth remains relatively constant, cycling from one reservoir to another from atmosphere to biosphere or ocean and back again. This is called the carbon cycle.

### Carbon Cycle Puzzle

**You will need:**

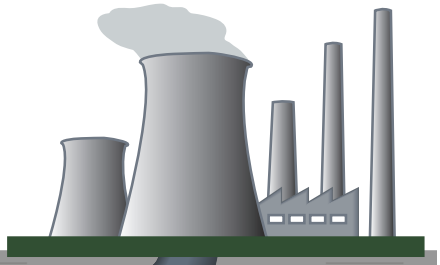
- 2x A4 sheets of blank paper
- pencils and pens
- scissors
- Carbon Cycle Puzzle printouts

**Instructions:**

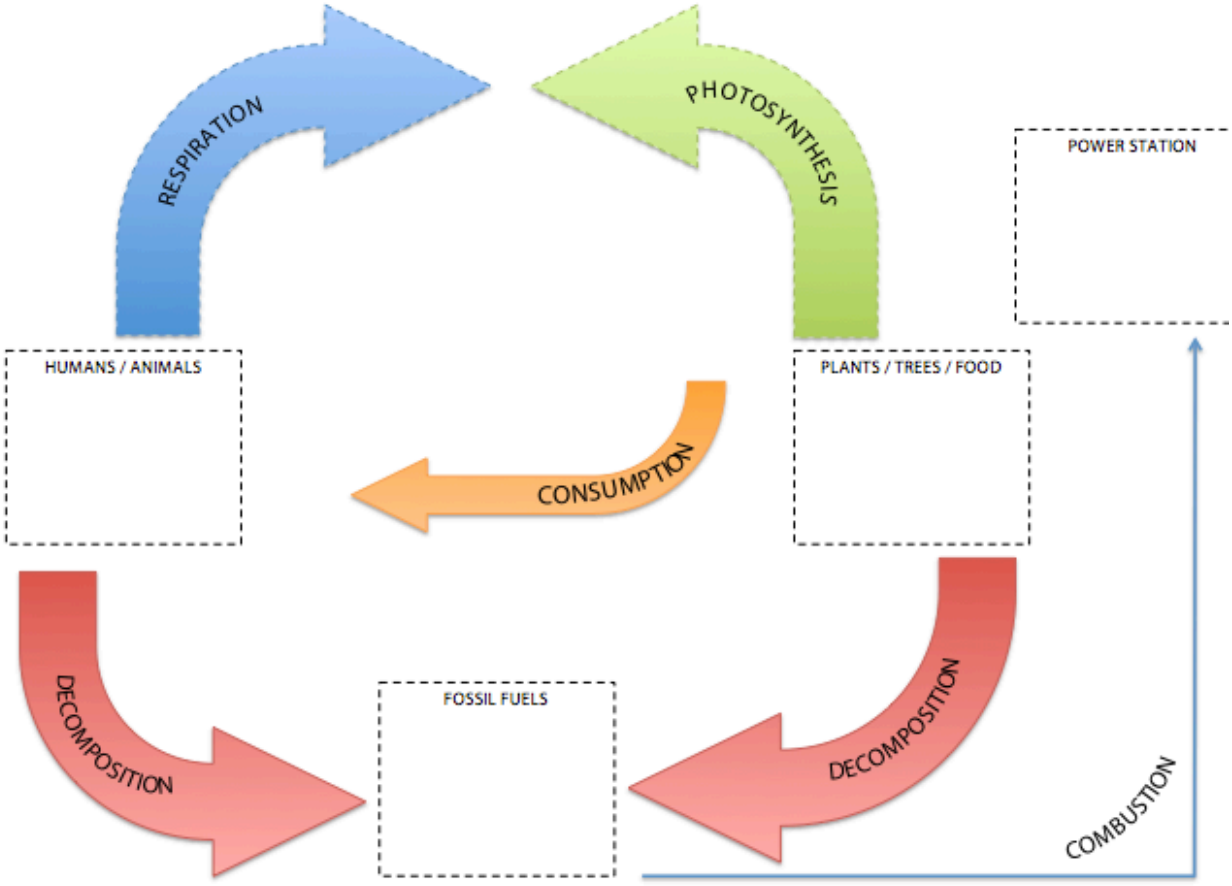
1. Draw the carbon exchangers (dashed boxes).
2. Cut out the carbon processes (arrows).
3. Arrange all the pieces in a circle to illustrate the order of the carbon cycle.

# The Carbon Cycle

## Teacher Notes



**Answer for Carbon Cycle Puzzle**




**Carbon Processes**

Photosynthesis – plants and trees take in $CO_2$ and turn it into carbohydrates to live off
Respiration – humans and animals give out $CO_2$ when they exhale
Consumption – most foods consumed by humans and animals contain carbon
Combustion – when fossil fuels (hydrocarbons) are burned $CO_2$ gas is given off

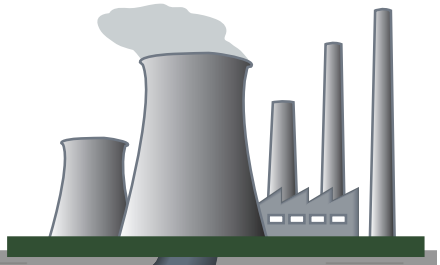
**Modern Problems with the Carbon Cycle**

As we take more and more fossil fuels out of the ground and burn them to generate electricity, our contribution of carbon to the atmospheric reserve, in the form of $CO_2$, increases.

$CO_2$ is a greenhouse gas. Greenhouse gases help regulate the temperature on earth by providing insulation to the atmosphere – just like thermal underwear does to your body.

# The Carbon Cycle

## Teacher Notes



**Answers to the Carbon Reserves Task (Student Worksheet)**

| *Reserves:* | *Carbon Stored* (*gigatonnes*): |
|---|---|
| Atmosphere | 810 |
| Biosphere | 1,900 |
| Oceanic | 39,000 |
| Mineralogical (rocks) | 4000 |

! Increased atmospheric $CO_2$ causes the oceans to absorb more carbon. This disrupts the chemistry of seawater, inhibiting the growth of corals and other sensitive marine organisms.

When $CO_2$ dissolves in raindrops it produces acid rain. Acid rain increases the weathering rates of certain rock types and causes damage to plants and buildings.

$CO_2$ is a greenhouse gas associated with climate change. It increases the frequency and severity of extreme weather events and makes global temperature rises.

Q: Can you name three consequences of increased atmospheric $CO_2$?
A: Acid rain, ocean acidification, increased weathering rates, global warming.

**Talking Point**

How can we reduce or prevent our $CO_2$ contribution to the atmosphere?

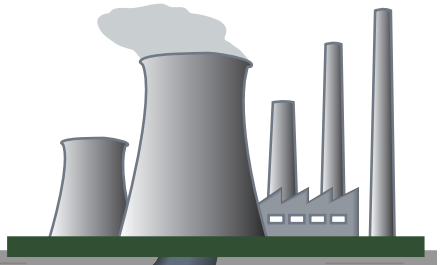
- Use more renewables
- Be more energy conscious
- CCS!

! **What is CCS?**

Scientists have developed a technology that allows the $CO_2$ emissions from a power plant or industrial source to be captured, transported deep underground and stored in a safe and secure geological location.
This technology has been adapted from a process called enhanced oil recovery (EOR) where $CO_2$ is pumped underground to increase the pressure in a reservoir to allow the last remaining bits of fuel to be extracted.

# The Carbon Cycle

## Teacher Notes



**Extension Experiment**
**Juice Carton Enhanced Oil Recovery Experiment**

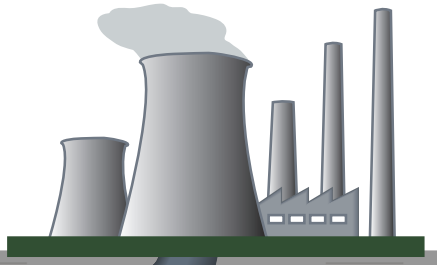
**You will need:**
1x juice carton per student with straw

**Instructions**

1. The student drinks all but 1cm of the juice in the carton.
2. They then blow gently into the straw to increase the pressure inside the carton.
3. The pressure difference between the inside of the carton and the outside encourages the last of the liquid to travel up the straw and into their mouth.
4. This is the exact principle used in EOR.

# The Carbon Cycle

## Printable Resources



RESPIRATION

PLANTS / TREES / FOOD

HUMANS / ANIMALS

FOSSIL FUELS

POWER STATION

COMBUSTION

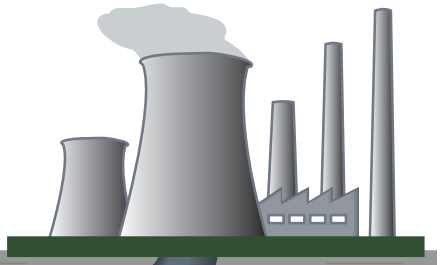
CONSUMPTION

DECOMPOSITION

DECOMPOSITION

# The Carbon Cycle

## Student Worksheet



The chemical symbol for carbon is _____

Name three forms of carbon 1_____

2_____

3_____

The process of carbon circulating around the biosphere, atmosphere and oceans is called the _____.

**Carbon Cycle Puzzle**

**You will need:**

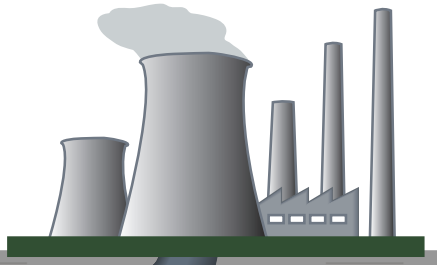
- 2x A4 sheets of blank paper
- pencils and pens
- scissors
- Carbon Cycle Puzzle printouts

**Instructions:**

1. Cut each piece of paper into four equal sheets.
2. On each sheet draw one of the following carbon exchangers:
    a. Atmosphere
    b. Plants/Trees
    c. Humans/Animals
    d. Fossil Fuels
    e. Power Station
3. Write the name of the exchanger below the picture.
4. Use the cards you have just made and the printouts of arrows and processes to arrange the components of the carbon cycle so that they make a complete circle.

# The Carbon Cycle

## Student Worksheet



When it is not part of the exchange cycle, carbon is stored in reserves. Match each of the four reserves with the amount of carbon stored in them on average at any one time.

| *Reserves* | *Carbon Stored (gigatonnes)* |
|---|---|
| Atmosphere | 39,000 |
| Biosphere | 810 |
| Ocean | 1,900 |
| Minerals | 4,000 |

The natural carbon cycle is balanced; each component exchanges with another so the reserves remain mostly constant. What man-made activity is disturbing the natural cycle?

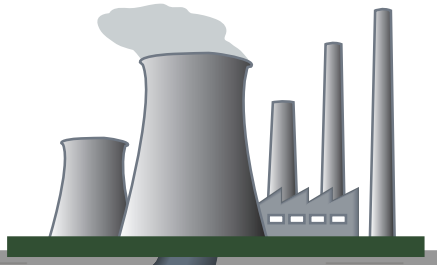
_____

When we take _____ _____ out of the ground, and burn them to create electricity and heat, we emit _____ _____ gas. _____gas contributes to global warming by preventing the _____rays from escaping into _____.

**WORD BANK**: carbon dioxide, $CO_2$, fossil fuels, space, sun's

# The Carbon Cycle

## Student Worksheet



Write down three consequences of more $CO_2$ in the atmospheric reserves.

If we want to keep using fossil fuels we need to come up with a solution to reduce the amount of $CO_2$ in our atmospheric reserve.

**Carbon Capture and Storage**

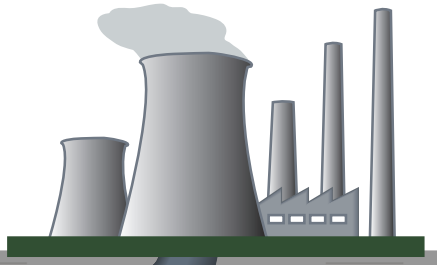
Scientists have come up with a technology that _____ $CO_2$ gas as it is emitted and _____ it to suitable geological storage sites where it is pumped _____to be stored.

**WORD BANK**: transports, underground, captures

**Extension Experiment**
**Juice Carton Enhanced Oil Recovery**
**You will need:**
1x carton of juice
1x A4 sheet to write up the experiment results

*Listen carefully to your teacher for instruction before conducting this experiment.*

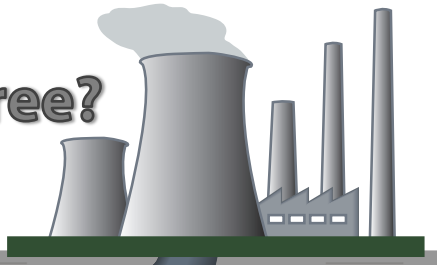
Chapter 1



# 4. How Much $CO_2$ Can You Store in a Tree?

# How Much $CO_2$ Can You Store in a Tree?

## Teacher Notes



| | |
|---|---|
| Activity Description | The students find a tree within the school grounds to measure. The students measure the tree and record their results on scrap paper. Back in the classroom, they transfer these results onto the worksheet provided to help them make the calculations. |
| Time | 1 hour |
| Learning Outcomes | • To understand that trees are a natural carbon sink<br>• To calculate the amount of carbon stored in a real tree<br>• To understand the implications of carbon sinks and sources |
| Student Organisation | Individual (calculation) and Groups (discussion) |
| Materials Needed | How Much $CO_2$ Can You Store in a Tree Student Worksheet, a tape measure **or** a metre stick and some string |

**Task**

This task allows us to quantify the amount of carbon, and equivalent $CO_2$ gas, stored in a tree.

**Talking Points**

Trees are a natural carbon sink. Get the students to think about other $CO_2$ sources and sinks.

*Sources:*

Fossil fuels, leaks, biological sources

*Sinks:*

Oceans, atmosphere, plants, land, precipitation of carbonate minerals in rocks

**Outdoor Instructions**

1. Get the students to work in pairs. One student measures from the ground 1.3m (or chest height) up the trunk of the tree, the other marks their place. Then the second student measures the circumference of the tree at this height. The height ensures a fair representation of the tree circumference is recorded.
2. The students record each measurement, both times on scrap paper.

**Talking Points**

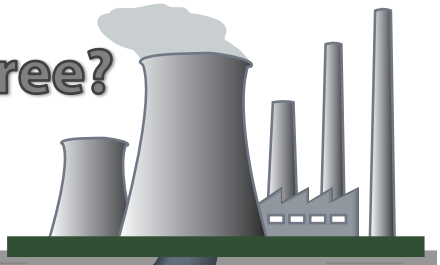
Get the students to think about what might affect the amount of carbon stored; do older trees store more carbon; does the type of tree make a difference; does the environment that the tree is in contribute to amount of carbon stored?

**Classroom Instructions**

Get the students to follow the instructions on the handout to complete the worksheet – there is a worked example at the end of this pack to help.

# How Much $CO_2$ Can You Store in a Tree?

# Teacher Notes



**Discussion**

Talk to the students about the link between trees and carbon: that carbon is locked up within trees but when trees are burnt for firewood, that carbon is released. Furthermore if the tree is buried and subject to heat and pressure over millions of years, the tree will become coal. Coal is a fossil fuel and burning fossil fuels releases $CO_2$ to the atmosphere. An increase in $CO_2$ in the atmosphere will lead to global warming.

**Summary**

Ask the students to think about how effective planting trees is, as a means to reduce carbon concentrations in the atmosphere. Consider: the rate at which trees grow, their environmental surroundings, the amount of carbon taken in from tree to tree and the lifetime of a tree. We may need a more immediate solution..

**Worked Example**

| tree circumference 1 | | tree circumference 2 | |
|---|---|---|---|
| *132* | **cm** | *144* | **cm** |

**A) Calculate the average of your two measured circumferences.**

*Why? This removes human bias from the measurements. Human bias is when the measurement is affected by the person who took it.*

| tree circumference 1 | | tree circumference 2 | | number of measurements |
|---|---|---|---|---|
| *132* | + | *144* | ÷ | *2* |

= *138* **cm**

# How much $CO_2$ can be stored in a tree?

# Teacher Notes

| average tree circumference | | estimated dry weight | |
|---|---|---|---|
| 138 | cm | 1964 | kg |

*The estimated dry weight of the tree is a) the closest value to the average tree circumferences in the references figures or b) read off the graph, whichever you prefer your students to do.*

**B) Calculate the weight of carbon stored in the tree.**

*How? Most living things are half carbon. Therefore we can estimate the carbon content by dividing the dry weight of the tree by 2. See reference figures for dry weight estimates.*

| estimated dry weight | | | weight of carbon in tree | |
|---|---|---|---|---|
| 1964 | ÷ 2 | = | 982 | kg |

| weight of carbon in tree | | equivalent weight of $CO_2$ | |
|---|---|---|---|
| 982 | kg | 3603.9 | kg |

**C) Calculate the equivalent weight of $CO_2$ gas stored as carbon in the tree.**

*How? We can calculate the equivalent weight of $CO_2$ stored as carbon in the tree by multiplying the estimated weight by the constant 3.67, as given by www.forestsforthefuture.co.uk.*

| weight of carbon in tree | | | equivalent weight of $CO_2$ | |
|---|---|---|---|---|
| 982 | x 3.67 | = | 3603.9 | kg |

# How much $CO_2$ can be stored in a tree?

# Teacher Notes

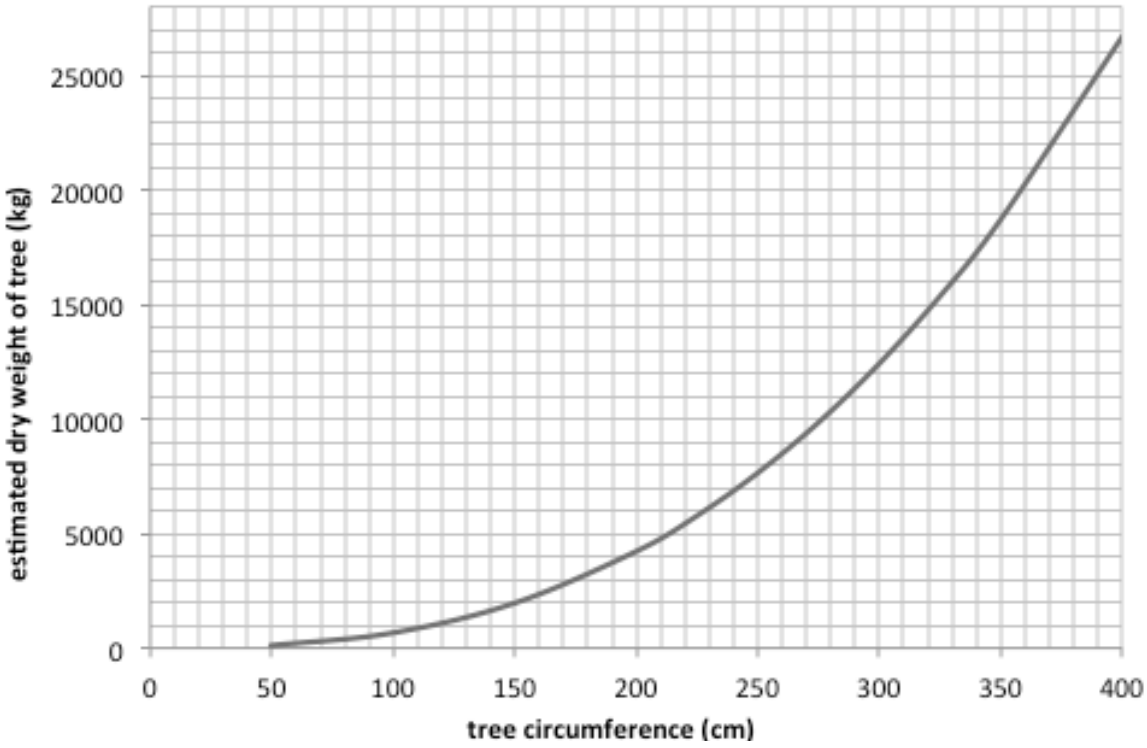
**Reference Table: Dry Weight of a Tree**

| Circumference (cm) | Tree dry weight (kg) |
|---|---|
| **50** | 106 |
| **100** | 668 |
| **150** | 1964 |
| **200** | 4221 |
| **225** | 5771 |
| **250** | 7641 |
| **275** | 9842 |
| **300** | 12410 |
| **325** | 15350 |
| **350** | 18700 |
| **400** | 26674 |

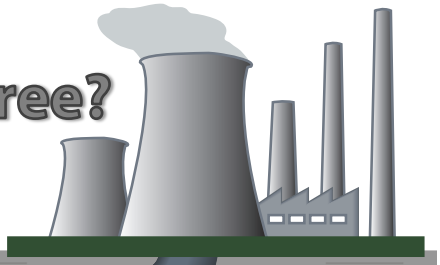
*These values, provided by **Forest Research**, are for an individual hardwood tree in Westonbirt Arboretum. They should be used as an **example**.*

*Trees will grow at different rates across the UK depending on, for example, the species, soil, drainage, slope aspect and climate conditions.*

**Reference Graph: Dry Weight of a Tree**



# How Much $CO_2$ Can Be Stored in a Tree?
# Student Worksheet



Plants, flowers and trees absorb $CO_2$ from the atmosphere. They use this $CO_2$ gas during photosynthesis to create carbohydrates, which help them grow. This process locks away $CO_2$ in the plant structure and helps regulate the levels of $CO_2$ in our atmosphere. The size of the tree directly relates to the amount of $CO_2$ locked inside. Older trees store more $CO_2$.

This activity consists of a field experiment. You and a partner measure a nearby tree before using some simple calculations to estimate the amount of $CO_2$ gas secured by the tree.

**How Much $CO_2$ Can Be Stored in a Tree Experiment**
**You will need:**

- A soft tape measure or/ string and a metre rule
- This worksheet
- A research partner
- A nearby tree

**Field Instructions:**

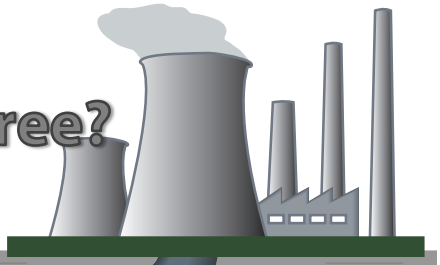
1. Take turns in pairs.
2. Measure 1.3m from the ground up the trunk of the tree and hold your finger on that point.
3. Ask your partner to measure around the trunk of the tree at the height you are holding your finger. Record your results on scrap paper and transfer these into your worksheet in class. (You should have two measurements, yours and your partner's).

**Classroom Instructions:**

1. Copy your tree measurements over from your scrap paper to the worksheet.
2. Calculate the average tree circumference.
3. Use this to estimate and record the dry weight of the tree using the table or the graph provided.
4. Calculate and record the weight of carbon stored by the tree.
5. Calculate the equivalent weight of $CO_2$ stored in the tree as carbon, over the tree's lifetime of growth.

# How Much $CO_2$ Can Be Stored in a Tree?

## Student Worksheet



| tree circumference 1 | | tree circumference 2 | |
|---|---|---|---|
| | cm | | cm |

**A) Calculate the average of your two measured circumferences.**

*Why? This removes human bias from the measurements. Human bias is when the measurement is affected by the person who took it.*

| tree circumference 1 | | tree circumference 2 | | number of measurements |
|---|---|---|---|---|
| | + | | ÷ | |

| = | | cm |
|---|---|---|

| average tree circumference | | estimated dry weight | |
|---|---|---|---|
| | cm | | kg |

**B) Calculate the weight of carbon stored in the tree.**

*How? Most living things are half carbon, therefore we can estimate the carbon content by dividing the dry weight of the tree by 2. See reference figures for dry weight estimates.*

| estimated dry weight | | 2 | = | weight of carbon in tree | |
|---|---|---|---|---|---|
| | ÷ | | | | kg |

# How much $CO_2$ can be stored in a tree?

## Student Worksheet

**weight of carbon in tree**

kg

**C) Calculate the equivalent weight of carbon dioxide gas stored as carbon in the tree.**

*How? We can calculate the equivalent weight of $CO_2$ stored as carbon in the tree by multiplying the estimated weight by the constant 3.67, as given by www.forestsforthefuture.co.uk.*

weight of carbon in tree

x 3.67 =

equivalent weight of $CO_2$

kg

**equivalent weight of $CO_2$**

kg

**Reference Table: Dry Weight of a Tree**

| Circumference (cm) | Tree dry weight (kg) |
|---|---|
| **50** | 106 |
| **100** | 668 |
| **150** | 1964 |
| **200** | 4221 |
| **225** | 5771 |
| **250** | 7641 |
| **275** | 9842 |
| **300** | 12410 |
| **325** | 15350 |
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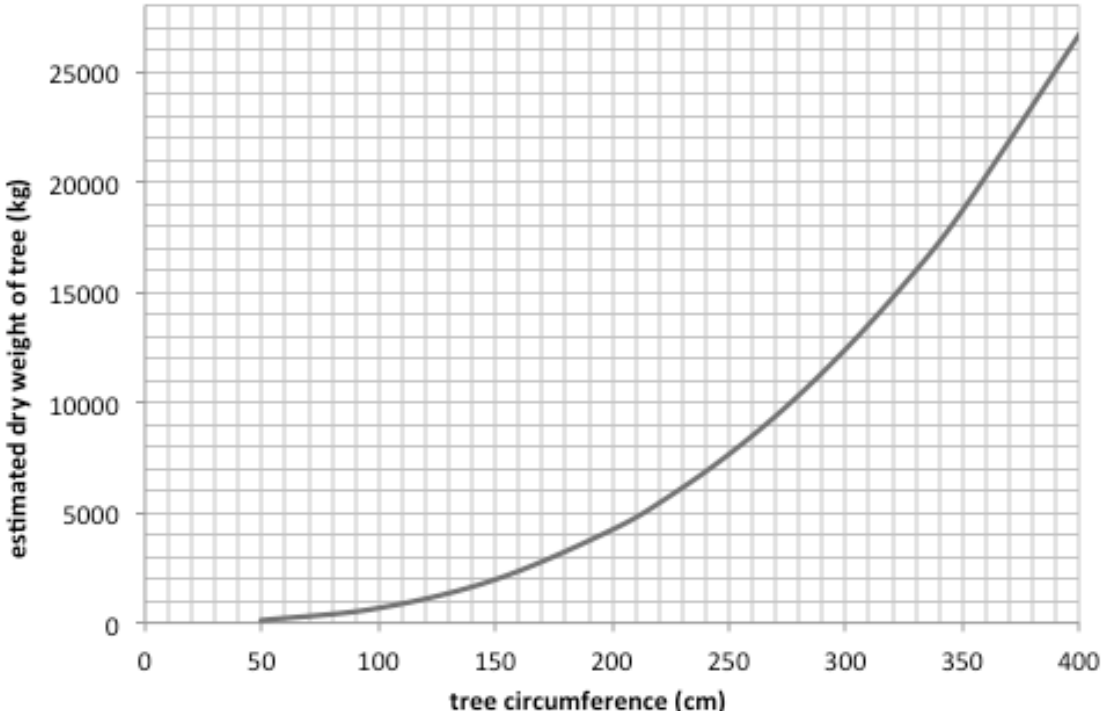
*Trees will grow at different rates across the UK depending on, for example, the species, soil, drainage, slope aspect and climate conditions.*

# How much $CO_2$ can be stored in a tree?

## Student Worksheet

**Reference Graph: Dry Weight of a Tree**



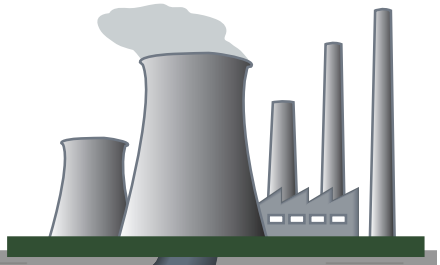

So, you have just calculated that the tree you measured contains _____ kg carbon, and _____ kg equivalent weight of $CO_2$ gas.

For scale
The average UK coal-fired power station emits 1kg of $CO_2$ per kWh generated.
1kWh of electricity will power:

| | |
|---|---|
| ONE **dishwasher** for 1 hour | ONE **hoover** for 2 hours |
| ONE **TV** for 3 hours | ONE **freezer** for 4 hours |
| ONE **games console** for 5 hours | ONE pair of **straighteners** for 11 hours |
| ONE **laptop** for 22 hours | ONE **aquarium** for 33 hours |

Note
A molecule of $CO_2$ gas contains two (relatively heavy) oxygen atoms for every single carbon atom, so a single $CO_2$ molecule weighs more than a single carbon atom.

Chapter 1



# 5. The CCS Cinema

# The CCS Cinema

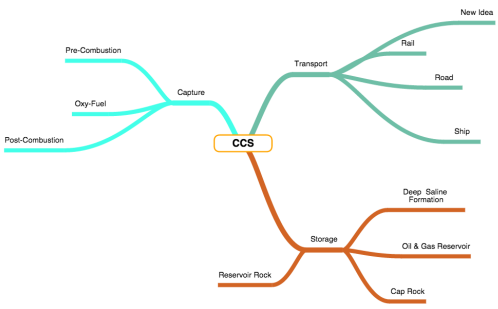
## Teacher Notes

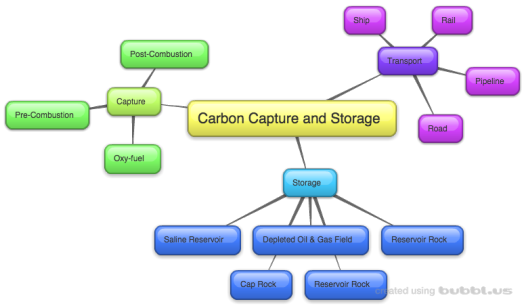
| | |
|---|---|
| Activity Description | The students learn about the basic principles and terminology of the carbon cycle, $CO_2$ emissions, and carbon capture and storage technology through a series of videos. They learn to create mind maps to retain information from these videos. |
| Time | 1 hour |
| Learning Outcomes | • To understand what $CO_2$ is, where it comes from and why it is a problem<br>• To create a Mind Map<br>• To understand the basics of the carbon cycle<br>• To understand basic carbon capture and storage terminology |
| Student Organisation | Individual or groups |
| Materials Needed | A4 paper and coloured pencils ***or*** computer and internet access<br>CCS Cinema Student Worksheet |

### Classroom Task

The students use computers to access and watch the four videos listed below. They then generate mind maps to summarise the important information from each video. The students can watch each video as many times as is required.

Mind maps can be drawn by hand or using an online mind mapping tool such as *bubbl.us* ***or/*** *drichard.org/mindmaps/#* illustrated in the examples below.




The students should complete the questions on the CCS Cinema Student Worksheet once they are happy their mind maps contain all the relevant information.

**Video Links:**

- More Energy, Less CO2. Shell.
  https://www.youtube.com/watch?v=mQ8yfVV9i0U
- Climate 101, with Bill Nye.
  https://www.youtube.com/watch?v=3v-w8Cyfoq8
- Capturing Carbon to Store it Underground, Shell.
  https://www.youtube.com/watch?v=f3T9B83rZss
- What to do with CO2?
  http://www.wonderville.ca/asset/whattodowithCO2

# The CCS Cinema

## Student Worksheet

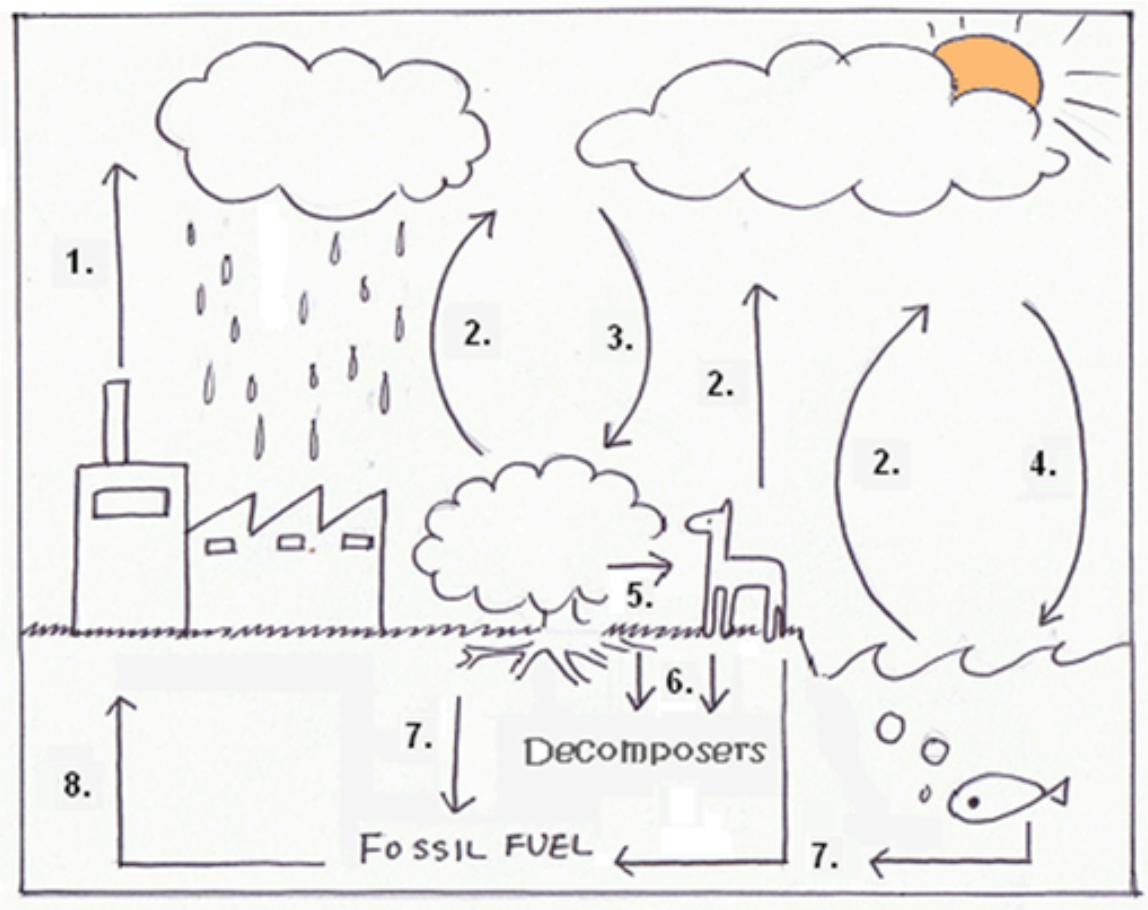
Mind maps are a good way of presenting information you need to remember. They use colours and connected lines to help your brain to link and recall tricky concepts.

Watch the following videos and make an A4 mind map for each one.

- More Energy, Less $CO_2$. Shell.
- Climate 101, with Bill Nye.
- Capturing Carbon to Store it Underground, Shell.
- What to do with $CO_2$?

Use your mind maps to help you answer the following questions:

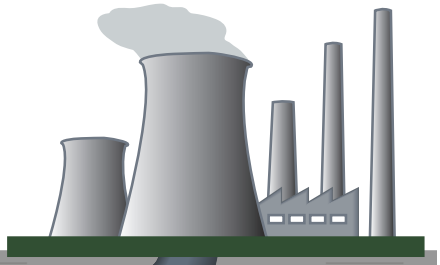
1. Where can you find carbon?




*Artwork by Julie Han*

# The CCS Cinema

## Student Worksheet



2. Can you match the numbers to the processes of the carbon cycle illustrated on the previous page?

| | |
|---|---|
| 1 | decomposition |
| 2 | respiration |
| 3 | extraction |
| 4 | fossilisation |
| 5 | oceanic exchange |
| 6 | photosynthesis |
| 7 | consumption |
| 8 | combustion |

3. What is the problem with $CO_2$?

4. Can you draw a molecule of $CO_2$?

5. Can you name three types of fossil fuel?

6. Can you describe carbon capture and storage in three sentences?