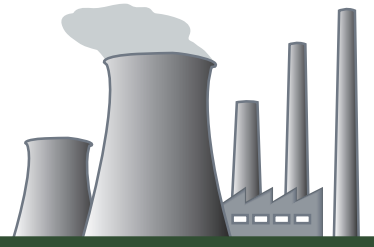


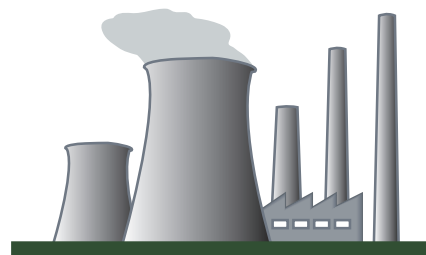
# Chapter 1



## 3. The Carbon Cycle

# The Carbon Cycle

## Teacher Notes



Activity Description	The students will learn about carbon, the carbon cycle, CO <sub>2</sub> emissions, their environmental significance and the role of CCS in this system.
Time	1–2 hour(s)
Learning Outcomes	<ul style="list-style-type: none"><li>• To understand the basic chemistry of carbon</li><li>• To understand the carbon cycle and its components</li><li>• To understand the imbalance within the carbon cycle due to CO<sub>2</sub> emissions</li></ul>
Student Organisation	Individual / Groups / Class
Materials Needed	Carbon Cycle Student Worksheet, Enhanced Oil Recovery Experiment 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:

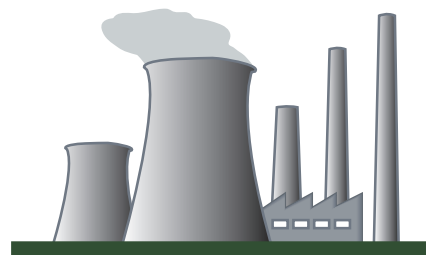
- 2x A4 sheets of blank paper
- pencils and pens
- scissors
- Carbon Cycle Puzzle printouts

#### Instructions:

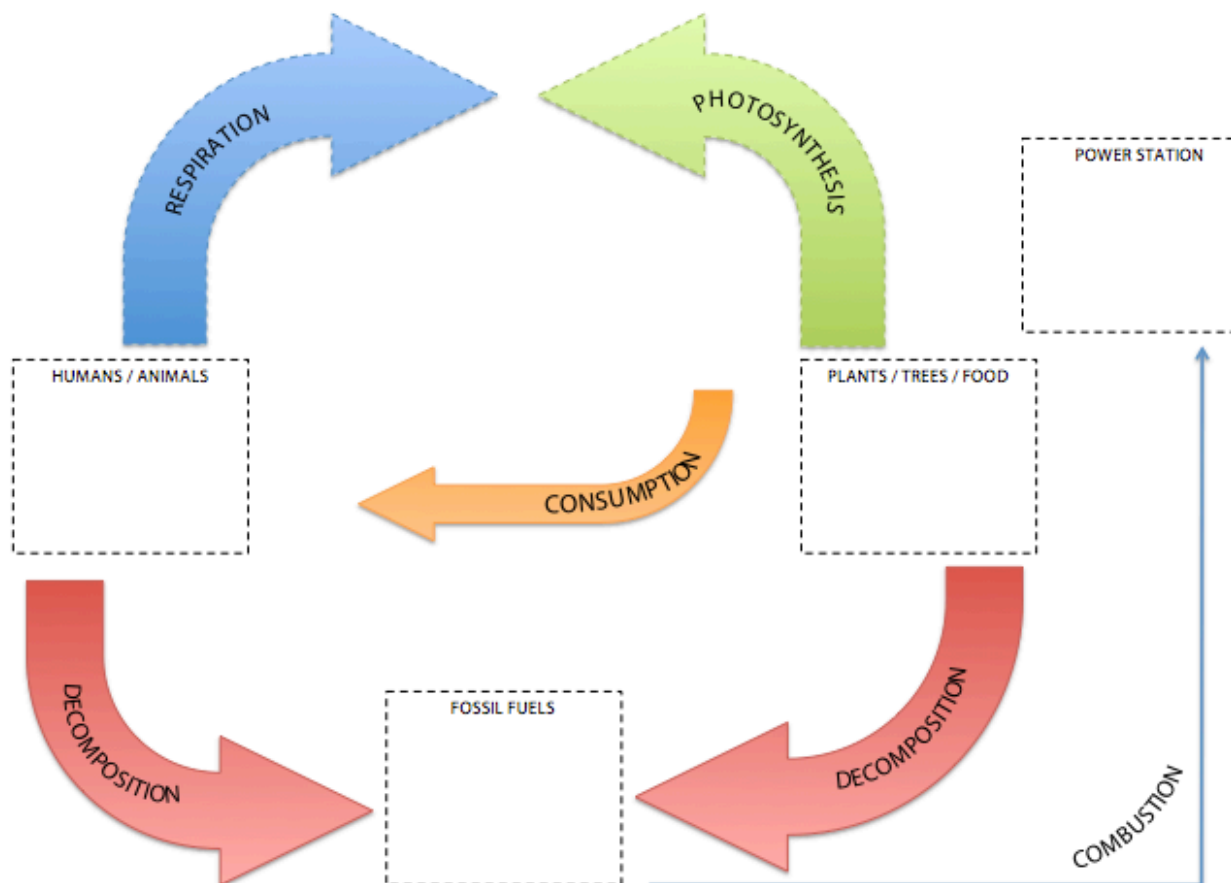
1. Draw the carbon exchangers (dashed boxes).
2. Cut out the carbon processes (arrows).
3. Arrange all the pieces in a circle to illustrate the order of the carbon cycle.

# The Carbon Cycle

## Teacher Notes



### Answer for Carbon Cycle Puzzle



### Carbon Processes

Photosynthesis – plants and trees take in  $\text{CO}_2$  and turn it into carbohydrates to live off

Respiration – humans and animals give out  $\text{CO}_2$  when they exhale

Consumption – most foods consumed by humans and animals contain carbon

Combustion – when fossil fuels (hydrocarbons) are burned  $\text{CO}_2$  gas is given off

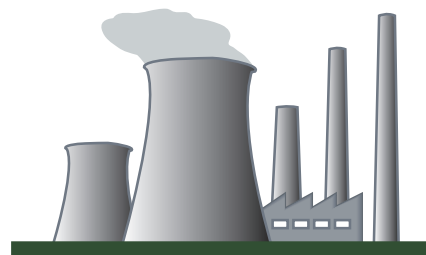
### ! Modern Problems with the Carbon Cycle

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  $\text{CO}_2$ , increases.

$\text{CO}_2$  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)

<i>Reserves:</i>	<i>Carbon Stored (gigatonnes):</i>
Atmosphere	810
Biosphere	1,900
Oceanic	39,000
Mineralogical (rocks)	4000

! Increased atmospheric CO<sub>2</sub> 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<sub>2</sub> 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<sub>2</sub> 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<sub>2</sub>?

A: Acid rain, ocean acidification, increased weathering rates, global warming.

### Talking Point

How can we reduce or prevent our CO<sub>2</sub> contribution to the atmosphere?

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

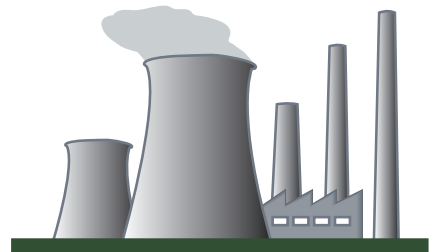
### ! What is CCS?

Scientists have developed a technology that allows the CO<sub>2</sub> 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<sub>2</sub> 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

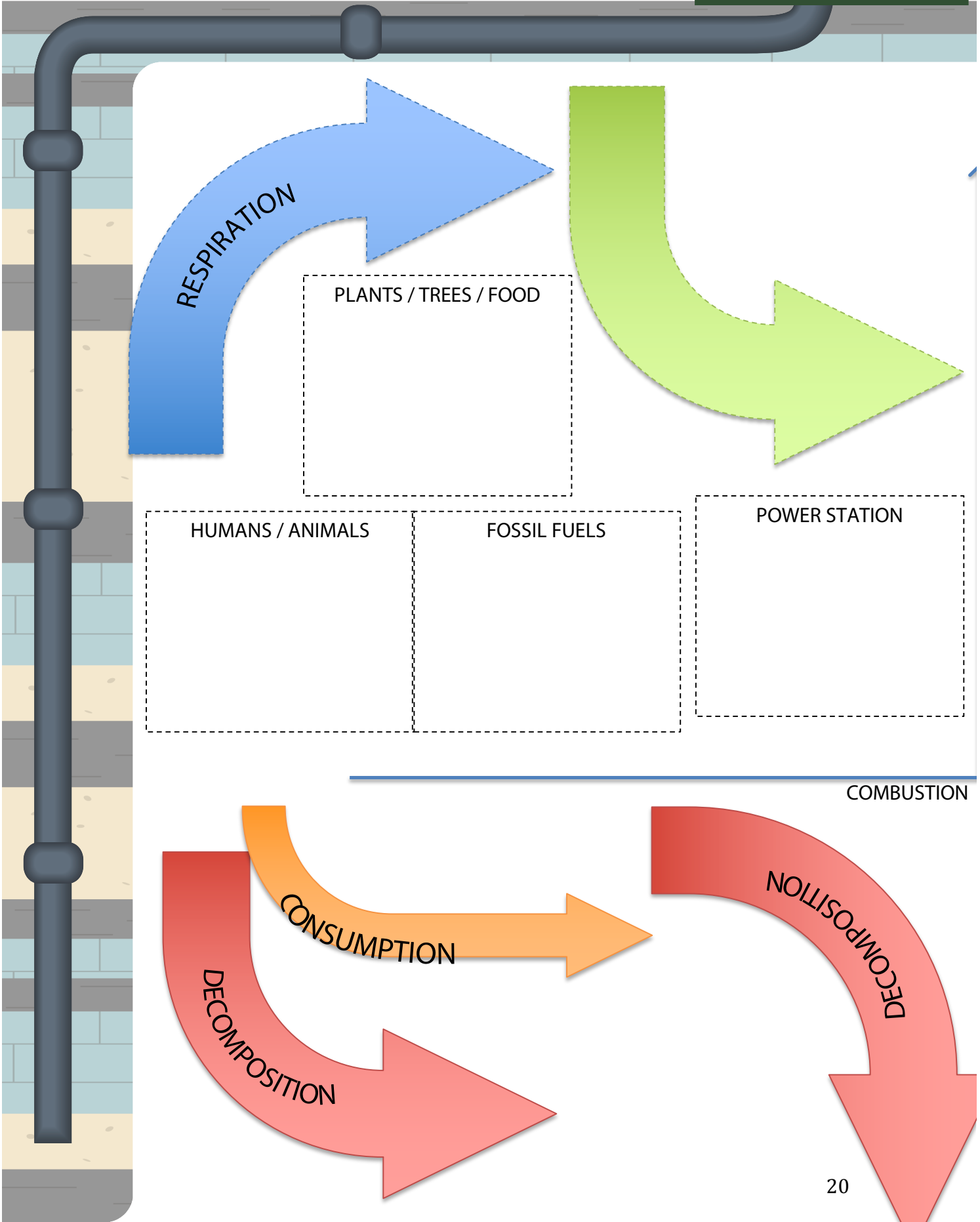
##### You will need:

1x juice carton per student with straw

##### Instructions

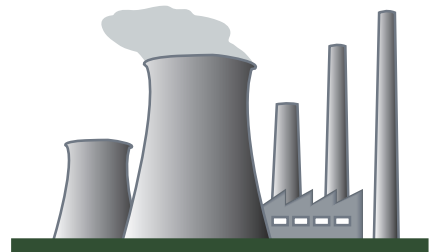
1. The student drinks all but 1cm of the juice in the carton.
2. They then blow gently into the straw to increase the pressure inside the carton.
3. The pressure difference between the inside of the carton and the outside encourages the last of the liquid to travel up the straw and into their mouth.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

## Printable Resources



# 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:

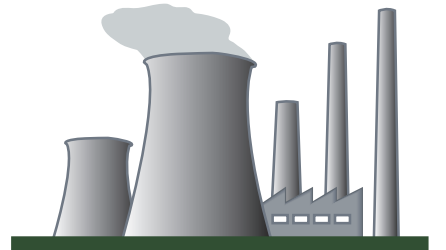
- 2x A4 sheets of blank paper
- pencils and pens
- scissors
- Carbon Cycle Puzzle printouts

#### 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.

<i>Reserves</i>	<i>Carbon Stored (gigatonnes)</i>
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?

\_\_\_\_\_

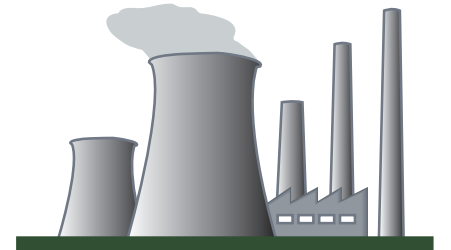
When we take \_\_\_\_\_ out of the ground, and burn them to create electricity and heat, we emit \_\_\_\_\_ gas. \_\_\_\_\_ gas contributes to global warming by preventing the \_\_\_\_\_ rays from escaping into \_\_\_\_\_.

**WORD BANK:** carbon dioxide, CO<sub>2</sub>, fossil fuels, space, sun's



# The Carbon Cycle

## Student Worksheet



Write down three consequences of more CO<sub>2</sub> in the atmospheric reserves.

A simple black-outlined rectangular box intended for a student to write a consequence of increased atmospheric CO2.A simple black-outlined rectangular box intended for a student to write a consequence of increased atmospheric CO2.A simple black-outlined rectangular box intended for a student to write a consequence of increased atmospheric CO2.

If we want to keep using fossil fuels we need to come up with a solution to reduce the amount of CO<sub>2</sub> in our atmospheric reserve.

### Carbon Capture and Storage

Scientists have come up with a technology that \_\_\_\_\_ CO<sub>2</sub> 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.*