



Carbon Cycle in the Lab

High School Grades

Lesson Summary

Students will learn about different carbon sources and sinks and the release and storage processes for each of them.

Prior Knowledge & Skills

- Knowledge of the greenhouse effect and CO₂
- Knowledge of carbon as the main constituent of living organisms

AAAS Science Benchmarks

The Physical Setting

Processes that Shape the Earth

The Living Environment

Interdependence of Life

Flow of Matter and Energy

NSES Science Standards

Physical Science

Chemical Reactions

Earth and Space Science

Geochemical Cycles

Science in Personal and Social Perspectives

Natural and Human Induced Hazards

Unifying Concepts and Processes

Change, Constancy, and Measurement

NCGE Geography Standards

Physical Systems

Standard 7

Teaching Time: ~1 hour

Materials

- 1 copy of The Carbon Cycle (Figure 1)
- 1 copy of The Carbon Cycle A4 sheet for each student
- 1 set of A4 sheets of 'products'
- 1 set of A4 sheets of 'processes'
- 1 set of specimens of 'products' *
 - Carbon dioxide in the atmosphere
 - Carbon in green plants
 - Carbon in animals
 - Carbon in soil
 - Carbon in seawater
 - Carbon in marine animals and plants
 - Carbon in coal and natural gas
 - Carbon in oil
 - Carbon in limestone

Advanced Planning

Preparation Time: ~10 minutes

1. Review the instructions
2. Gather the necessary supplies.
3. Place 'products' sheets in a rough circle on desks around the classroom

Recommended Reading: (attached)

- Various carbon cycle diagrams

*Editor's note: Examples of the 'products' specimens can be found under the activities Apparatus and materials section.

The Royal Society of Chemistry: JESEI

<http://www.chemsoc.org/Networks/Learnnet/jesei/lab/home.htm>

Carbon cycle in the lab: carbon products and the processes that link them (teacher's notes)

Topic

This activity is one of five aimed to teach students about the nature of **carbon**, the different types of compounds it exists in (eg charcoal, glucose, carbon dioxide), the biochemical reactions it takes part in (**photosynthesis** and **respiration**), the range of processes that carbon and carbon compounds are involved in on Earth, and how these link together to form the **carbon cycle**.

Context

An understanding of the carbon cycle is essential to the debate about **global warming**, an environmental issue that most students will have heard about. Since the Earth's atmosphere formed, it seems to have always contained carbon dioxide in varying amounts. Carbon dioxide is a '**greenhouse gas**' through which light radiation can pass but which absorbs some of the heat radiation produced by light irradiating the Earth's surface. This causes the Earth's surface and atmosphere to be warmer than it would otherwise be and without the '**greenhouse effect**' the Earth would probably be completely frozen. Humans, as all life on Earth, have always been part of the carbon cycle, but now (since the industrial revolution) the large scale burning of oil, coal and natural gas, along with deforestation, is leading to increasing atmospheric carbon dioxide levels. This in turn is related to an enhanced greenhouse effect and consequent climatic change. An understanding of the factors affecting global warming leads to an understanding of the measures required to reduce their impact. This can link into economic and political debates on the subject. Students should have already covered photosynthesis and respiration in order to do this set of activities effectively.

Teaching points

The carbon cycle is a "big idea" that can be difficult to understand because parts of it work at a microscopic scale while other parts affect the whole Earth. Also, some parts happen in milliseconds whilst others can take millions of years to have an effect. We can get a feel for how the whole carbon cycle works by turning the lab into a model of the carbon cycle and seeing how the different things that are produced in the cycle (the products) fit together with the way those products are made (the processes).

Apparatus and materials

The teacher will need:

An OHT showing the carbon cycle (Figure 1).

A copy of the carbon cycle A4 sheet for each pupil (Figure 1).

Either a copy of *Carbon cycle in the lab: carbon products and the processes that link them (for pupils)* worksheet for each pupil or an OHT version

1 set of A4 sheets of 'products', (Carbon dioxide in the atmosphere, Carbon in green plants; Carbon in soil; Carbon in marine animals and plants/ Carbon in soft parts/ Calcium carbonate in hard parts; Carbon in coal and natural gas/ Carbon in oil/ Carbon in limestone; Carbon dissolved in seawater)

1 set of A4 sheets of 'processes', (dissolved in rain/ soil water - carried to sea; absorption by organisms; burial and rock formation; burial and decomposition in rock sequence; weathering; combustion; photosynthesis; consumption; death; excretion and death; respiration)

Set of specimens of 'products':

- Carbon dioxide in the atmosphere – a stoppered test tube, labelled 'Atmosphere'
- Carbon in green plants - grass or leaf (or a picture)
- Carbon in land animals - mirror
- Carbon in soil - bag of soil
- Carbon in seawater - test-tube of water labelled 'seawater'
- Carbon in marine animals and plants- sea shells
- Carbon in coal and natural gas - coal
- Carbon in oil – a stoppered, labelled test tube of crude oil (molasses could be used as a substitute if crude oil is not available)
- Carbon in limestone - limestone

To prepare:

A4 sheets of the 'products' of the cycle are put in a rough circle on desks around the room.

Keep the A4 sheets of the 'processes' for use later.

Safety

Be aware of the risk of breaking test-tubes.

Activity

Through discussion with the class, the teacher puts the specimens in the correct places on the carbon cycle product sheets laid out around the room.

Then, again through interactive discussion, the teacher puts the 'processes' sheets in the correct places between the products around the room.

Finally the pupils are shown an OHT version of the cycle and are given their own copies. They should write the examples of the 'products' they have been shown in the correct places on their version of the diagram. Faster pupils can then answer the questions on the worksheet.

Questions

Which products of the carbon cycle:

- Q 1. can you see out of the window? = *Green plants, land animals, soil, limestone.*
- Q 2. can you never see? = *Carbon dioxide in the atmosphere and dissolved in seawater, natural gas.*
- Q 3. might you see in a quarry? = *Limestone, coal, soil, plants, land animals, the hard parts of marine animals.*
- Q 4. are fluids (liquids or gases)? = *Carbon dioxide in the atmosphere, natural gas, oil, dissolved carbon dioxide in seawater.*
- Q 5. last the longest? = *Limestone, coal, oil/natural gas trapped in rocks, carbon dioxide in the atmosphere.*
- Q 6. might affect global warming? (*This is for the more able/interested and is a 'warm up' for activities to come!*) = *Greenhouse gases carbon dioxide and methane (natural gas); coal, oil, natural gas that will produce carbon dioxide when burned, green plants that remove CO₂ in photosynthesis, animals and plants that release CO₂ in respiration (all the other products may affect global warming too, eg weathering of limestone releases more CO₂, when there is more CO₂, plant life is more prolific and the animal life feeding on the plant life is more prolific, etc).*

THE CARBON CYCLE

KEY:

Carbon cycle product

carbon cycle process

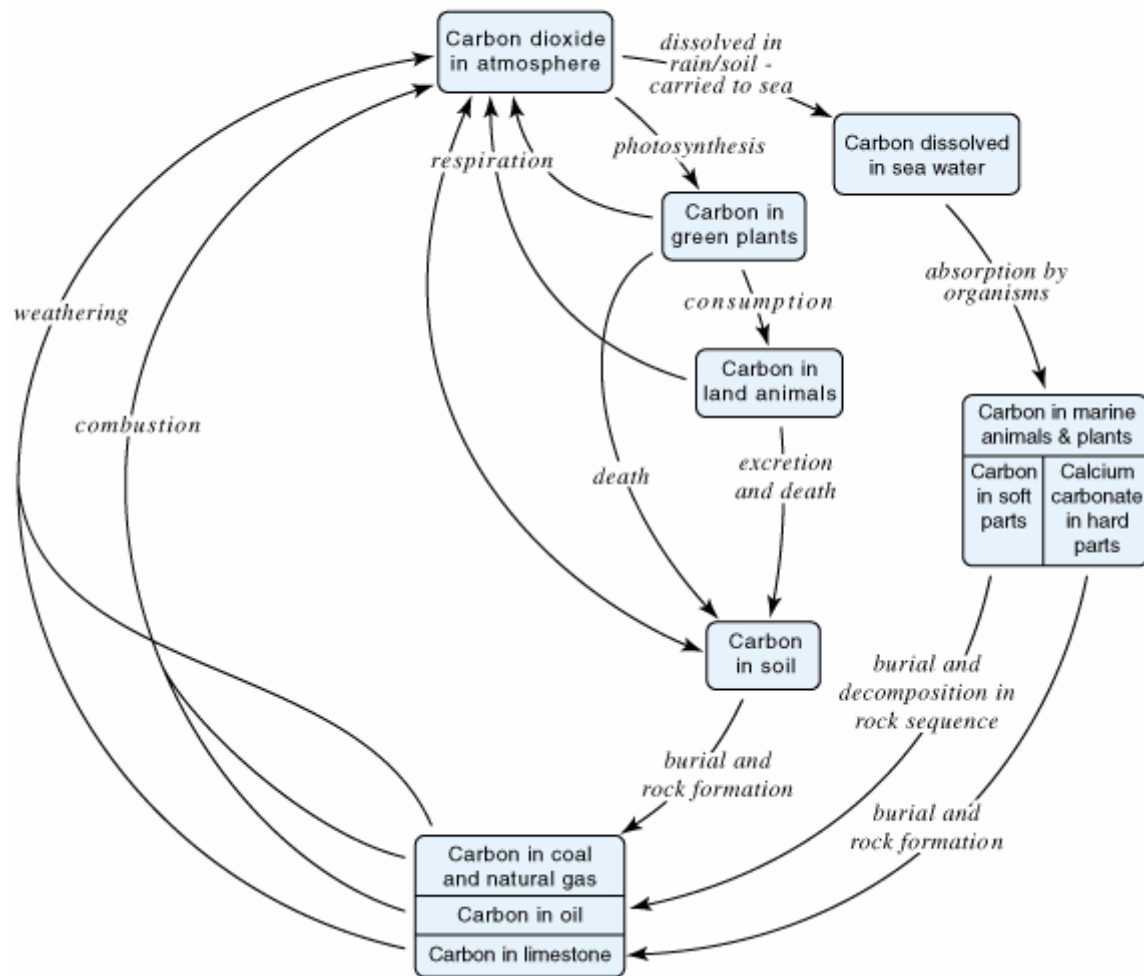


Figure 1 The carbon cycle

Carbon dioxide in atmosphere

Carbon in green plants

Carbon in land animals

Carbon in soil

Carbon in marine animals and plants

**Carbon
in
soft parts**

**Calcium
carbonate in
hard parts**

**Carbon in coal and
natural gas**

Carbon in oil

**Carbon in
limestone**

Carbon dissolved in seawater

dissolved in rain/soil

water

- carried to sea

*absorption by
organisms*

*burial and rock
formation*

*burial and
decomposition in
rock sequence*

*burial and rock
formation*

weathering

combustion

photosynthesis

consumption

death

excretion and death

respiration