

# EXPLORING THE CARBON CYCLE

## GRADES 7-12

### BACKGROUND

Carbon is an essential element of life on earth. While most of it is stored in rocks, all organic matter, including our bodies and all plants and animals, contain carbon. Humans and animals breathe in oxygen, which mixes with carbon in our bodies, and exhale carbon dioxide,  $\text{CO}_2$ , in the process known as respiration. Plants absorb  $\text{CO}_2$  and sunlight from the atmosphere and use it in the process of photosynthesis to make glucose, which gives them energy to fuel their metabolism.

Carbon occurs naturally in the earth in the form of fossil fuels. Most of the fossil fuels we use today are from animals and plants that decomposed long before dinosaurs walked the earth. When these organisms died, their remains decomposed and were eventually buried under layers of soil and rock. Over millions and millions of years, more and more layers covered the remains until they were buried deep under the earth. In some places the remains were covered by ancient rivers, seas, or swamps which have since dried up, and in some places today they are deep under the ocean. Decomposition of organic matter, pressure, and temperature are all part of this multi-million year process that formed the finite supply of fossil fuels that we have available to us today.

All of the carbon on earth is connected in a complex, interwoven carbon cycle. Carbon cycles through four major reservoirs—the atmosphere, hydrosphere, biosphere, and lithosphere (also called geosphere). The oceans and forests play a pivotal role in the carbon cycle, acting as carbon sinks. Carbon sinks are reservoirs that are able to absorb carbon from the atmosphere.

Volcanoes, respiration, wildfires, and ocean release are natural sources of carbon in the atmosphere in the form of  $\text{CO}_2$ . Coal, natural gas and oil are natural sources of carbon, but they seldom emit  $\text{CO}_2$  when they remain underground. However, burning fossil fuels to power our cars, homes, and industries releases more  $\text{CO}_2$  into the atmosphere than the carbon cycle can stabilize. The imbalance that is created by the inability of carbon sinks to store all of this excess  $\text{CO}_2$  and methane, another carbon-containing gas, causes these gases to build up in the atmosphere. Carbon and methane are known as greenhouse gases, which form an insulating blanket around Earth's atmosphere. Sunlight enters the atmosphere, but not all of it can exit when it is reflected back from the Earth's surface. This is known as the greenhouse effect. Without the greenhouse effect, the earth would not support life as we know it.

The intensification of the greenhouse effect, believed to be due to the combustion of fossil fuels, has caused the slow rise in temperatures referred to as climate change. We see some of the effects

of climate change in the extreme weather conditions that are occurring globally-drought, blizzards, floods, and extreme heat. As humans, our greatest contribution to climate change is the burning of fossil fuels to power our economies and daily lives.

#### **DEFINITIONS**

*Carbon*-A nonmetallic element found pure in nature (as in diamond and graphite) or as a part of coal and petroleum and in the bodies of living things; carbon is present in all organic matter

*Organic matter* - Matter composed of organic (carbon-containing) compounds from dead plants and animals and their waste

*Carbon cycle*-The combined processes by which carbon moves between the atmosphere, hydrosphere, biosphere, and lithosphere

*Carbon dioxide* (CO<sub>2</sub>)-The gaseous compound formed when two oxygen atoms combine with one carbon atom; the most prominent greenhouse gas emitted by human activity. Many emissions come from the combustion of fossil fuels

*Carbon sequestration*-The process of carbon from the atmosphere being stored in sinks

*Carbon sink*-A reservoir that has the ability to absorb CO<sub>2</sub> from the atmosphere, e.g. oceans and forests

*Climate change*-The change in global climate patterns attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels

*Combustion*-The process of burning something

*Fossil fuels*-Fuels that are the product of decomposing plants and animals from previous geological periods, typically before the time dinosaurs walked the earth; examples are oil, coal, and natural gas

*Ocean acidification*-Increasing acidity in the ocean caused by increased CO<sub>2</sub> in the atmosphere

*Greenhouse effect*-The accumulation of greenhouse gases that prevents all of the sun's energy from reflecting back from Earth's surface, trapping heat in the atmosphere

*Greenhouse gases*-Gases that absorb and emit infrared radiation, causing the greenhouse effect; the primary greenhouse gases in the earth's atmosphere include water vapor, CO<sub>2</sub>, methane, nitrous oxide, and ozone

*Methane* (CH<sub>4</sub>)-Second most prominent greenhouse gas emitted from human activities; emissions come from rice paddies, wetlands, the digestion of ruminants, industry, and landfills

*Natural resources*-Materials found in or on the Earth that are used by humans and other living things

*Photosynthesis*-The process by which green plants and some other living things use sunlight to convert carbon dioxide and water into sugar and oxygen

*Respiration*-The process of taking in oxygen and releasing CO<sub>2</sub>

*Biosphere*-The part of the earth and its atmosphere in which living organisms exist or that is capable of supporting life

*Lithosphere*-The crust and upper mantle of the Earth

*Hydrosphere*-All of the water found in glaciers, oceans, rivers, lakes, soil, groundwater and air

*Atmosphere*-The envelope of gases surrounding the earth or other planets

## **PART I - CARBON CYCLE BASICS**

### **INSTRUCTIONS**

1. Discuss natural resources with students. Begin by asking for a definition of natural resources. Make a list of natural resources elicited from students.
2. Give students the list of definitions to study.
3. Discuss carbon and its presence on the earth using the background information.
4. Define and explain the concept of carbon sinks. Forests, the ocean, and fossil fuels are all good at storing carbon and are considered carbon sinks.
5. Assign students the Carbon Cycle Worksheet. Allow them time to research the internet for answers. After completing the assignment, discuss their answers.
6. Once the students have a general understanding of the carbon cycle, they will be ready to play Carbon Cycle Jeopardy!

## **PART II - CARBON CYCLE JEOPARDY**

### **TEACHER PREPARATION**

1. Print copies of the Jeopardy Score Grid on last page or draw on board for keeping track of categories/dollar amounts that have been chosen.
2. Prepare paper or board for scorekeeping.
3. Divide class into teams- three is suggested. Students on each team will take turns choosing the category and responding when it is their team's turn.
4. Determine which team will go first.

### **INSTRUCTIONS**

1. Player from first team chooses category and dollar amount.
2. Click on the number box to get the answer.
3. The response must be phrased as a question- What is...? or What are...?
4. Click on the blue box for the correct response.
5. Click on the green star in the bottom right corner to return to the main screen.
6. Continue playing, with teams taking turns, until all of the questions have been answered.
7. Tally scores.
8. Now it is time for Final Jeopardy.
9. Hand out paper and a marker to each team.
10. Give Final Jeopardy question to all teams. Each team is to write the answer on the paper. Allow 30 seconds to respond.
11. Elicit each team's response, beginning with the team with the lowest score. Team with overall highest score wins.

### **MATERIALS**

Chalkboard, markerboard, paper for keeping track of answers that have been chosen  
1 piece of 8 1/2x11 plain white paper per team  
1 marker per team  
Carbon Cycle Jeopardy Game - In a large PowerPoint file, downloadable at [www.waterrocks.org](http://www.waterrocks.org)  
Optional: Stopwatch or timer. Allow 5-10 seconds for students to begin their response.

## **ADDITIONAL RESOURCES**

### For teachers:

[http://www.sciencedaily.com/articles/c/carbon\\_cycle.htm](http://www.sciencedaily.com/articles/c/carbon_cycle.htm)

(Overview of carbon cycle)

[http://www.oregonwild.org/oregon\\_forests/old\\_growth\\_protection/forests-global-warming/global-warming-report/part-ii-how-does-carbon-move-in-and-out-of-the-atmosphere](http://www.oregonwild.org/oregon_forests/old_growth_protection/forests-global-warming/global-warming-report/part-ii-how-does-carbon-move-in-and-out-of-the-atmosphere)

(Describes how carbon moves throughout the different reservoirs of the carbon cycle)

### For students:

<http://www.scienceforkids.kidipede.com/chemistry/atoms/carbondioxide.htm>

(Basics of carbon dioxide and carbon cycling on Earth)

[http://www.windows2universe.org/earth/climate/carbon\\_cycle.html](http://www.windows2universe.org/earth/climate/carbon_cycle.html)

(Carbon molecule game for students, information for teachers as well)

THE CARBON CYCLE	CARBON SOURCES	CARBON SINKS	EFFECTS OF CLIMATE CHANGE	GREENHOUSE GASES
\$100	\$100	\$100	\$100	\$100
\$200	\$200	\$200	\$200	\$200
\$300	\$300	\$300	\$300	\$300
\$400	\$400	\$400	\$400	\$400
\$500	\$500	\$500	\$500	\$500

Final Jeopardy Answer:

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# CARBON CYCLE WORKSHEET

Name \_\_\_\_\_

What are examples of natural resources?

Name some ways carbon is important for all living things.

What is carbon dioxide (CO<sub>2</sub>)?

What are natural sources of CO<sub>2</sub>?

What human activities produce CO<sub>2</sub> emissions? What activity produces the most?

What is a greenhouse gas? What are the top two greenhouse gases emitted into the atmosphere by human activity?

What are carbon sinks? Give two examples. What is the U.S.'s largest carbon sink? What is Earth's largest carbon sink?

**DEFINE THE FOLLOWING TERMS:**

ocean acidification:

carbon sequestration:

climate change:

combustion:

fossil fuels:

Draw the carbon cycle giving at least one example of it in the biosphere, atmosphere, hydrosphere, and lithosphere. Identify carbon sinks in your drawing.

\*\*\*Extra Credit\*\*\*

What is the current level of CO<sub>2</sub> in the atmosphere in ppm? (this can be found at [www.esrl.noaa.gov/gmd/ccgg/trends/](http://www.esrl.noaa.gov/gmd/ccgg/trends/))

## CARBON CYCLE WORKSHEET ANSWER KEY

**What are examples of natural resources?** (living organisms, rocks, minerals, soil, natural gas, petroleum, water)

**Name some ways carbon is important for all living things.** (carbon is present in all living things, answers should include examples from the carbon cycle, ie. photosynthesis)

**What is carbon dioxide (CO<sub>2</sub>)?** (the gas that is formed when two oxygen atoms and one carbon atom combine)

**What are natural sources of CO<sub>2</sub>?** (respiration, ocean release, decomposition, wildfires, volcanoes)

**What human activities produce CO<sub>2</sub> emissions? What activity produces the most?** (burning fossil fuels to produce electricity, combustion of gas and diesel fuel, production of cement, iron, steel, and chemicals-burning fossil fuels to produce electricity, especially coal)

**What is a greenhouse gas? What are the top two greenhouse gases emitted into the atmosphere by human activity?** (gases that build up in the atmosphere and form an insulating blanket around the atmosphere-co<sub>2</sub> and methane)

**What are carbon sinks? Give two examples. What is the U.S.'s largest carbon sink? What is Earth's largest carbon sink?** (carbon sinks are anything and stores or absorbs more carbon than it releases-forests, the ocean, fossil fuels, soil-forest, ocean)

**Define the following terms:**

**ocean acidification:** Increasing acidity in the ocean caused by increased CO<sub>2</sub> in the atmosphere

**carbon sequestration:** the process of carbon being removed from the atmosphere and being stored in carbon sinks or reservoirs

**climate change:** the change in global climate patterns attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels.

**combustion:** the process of burning something fossil fuels: fuels that are the product of decomposing plants and animals from previous geological periods, typically before the time dinosaurs walked the earth; examples are oil, coal, and natural gas

**fossil fuels:** fuels that are the product of decomposing plants and animals from previous geological periods, typically before the time dinosaurs walked the earth; examples are oil, coal, and natural gas

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