

# New Earth Classroom



## ACTIVITY 7 THE CARBON GAME

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### LEARNING OBJECTIVES

1. Students will be able to recognize carbon as the foundation of all living things.
2. Students will be able to name carbon dioxide as a component of the atmosphere.
3. Through the Carbon Game, students will demonstrate how carbon cycles through the Earth's atmosphere, ocean, photosynthesizing plants, and soil.
4. While playing the Carbon Game, students will read and follow instructions to simulate the cyclical nature of carbon.
5. Students will discuss how our everyday actions can impact levels of carbon in the atmosphere, ocean, plants, and soil.

### EQUIPMENT

#### **For background discussion:**

- Periodic table of elements (kid-friendly)
- Items that contain carbon (for example, a potted plant, egg shells, bones, graphite, stick, shoe box, apple, loaf of bread, soda or carbonated water, steel nails)
- Items that don't contain carbon (for example, pure metals, table salt, aluminum can, tap water)
- Visuals to show how carbon cycles through the environment (optional but helpful)

#### **For Carbon Game:**

- Shoelaces (1 per pair of students)
- Large beads to represent carbon units (15 beads per shoelace plus 40 more beads for carbon reservoir stations)
- Carbon reservoir signs on cardstock or posterboard: Atmosphere, Ocean, Plants, Soil
- 4 bowls or other containers for beads at carbon reservoir stations
- Scenario cards for Round 1 (60 blue cards) & Round 2 (60 green cards) (see reproducibles)
- 4 small labeled "Discard" boxes or bowls for used scenario cards at each carbon reservoir station

### KEY WORDS

carbon, periodic table, carbon dioxide, carbon cycle, carbon reservoir, atmosphere, photosynthesis

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## **SUMMARY & PREPARATION**

To prepare for the background discussion, display the periodic table on a wall or easel so students can easily view it. On a table or desk, place the items that contain carbon on one side and the items that don't contain carbon on the other side. If you have any visuals demonstrating how carbon cycles through the environment, display them for student viewing.

## **4 STATIONS** *different areas of classroom*

To set up for the Carbon Game, you will need four designated stations (one for each carbon reservoir) in different areas of the classroom, allowing students ample room to move comfortably between and visit each station. Each station will consist of: a sign indicating which carbon reservoir that station represents (Atmosphere, Ocean, Plants, Soil), a bowl or container with 10 loose beads, one "discard" box or bowl for used scenario cards, and 20 scenario cards. In the first round of the game, each station will have 15 blue scenario cards and 5 green scenario cards. In the second round of the game, each station will have 15 green scenario cards and 5 blue cards.

## **STRING BEADS** *15 beads on each shoelace*

To prepare for the game, string 15 beads on each shoelace and tie knots on both ends so the beads can't fall off. Students will work in pairs, so you will need enough beaded shoelaces to give one to each pair. If you have enough shoelaces and beads to make extras, that will save time between Round 1 and Round 2, because each pair of students will need a shoelace with 15 beads for Round 2 as well.

The class will begin with a discussion of what carbon is and where it exists in our environment (in both living and non-living things), followed by an overview of carbon dioxide and how an abundance of carbon dioxide can harm the environment.

The instructor will then rotate through the carbon reservoir stations and talk about how carbon is stored and cycles through each reservoir. Then, the instructor will explain the directions for the Carbon Game. During the game, students will read from the scenario cards and follow the directions by depositing beads (representing units of carbon) at or removing beads from each station.

The Carbon Game is played in two rounds. After Round 1, the beads in each "reservoir" will be counted and the cards will be sorted (and some reused) for Round 2. The class will discuss the results of Round 1. After Round 2, the beads in each "reservoir" will be counted, and the class will again discuss the results. To conclude, the class will consider how humans impact the carbon cycle and explore ways to reduce atmospheric and oceanic carbon while increasing carbon in plants and soil.

**BACKGROUND  
INFORMATION**  
30 minutes

**CARBON**

**I. BACKGROUND INFORMATION ABOUT CARBON: (30 mins)**

A. What is carbon?

1. **Carbon is one of Earth's basic elements**, like oxygen, hydrogen, sodium & nitrogen. Have students find these elements on the **periodic table**.
2. Carbon is one of the foundations of all living things. After oxygen, it's the second most abundant element in the human body. Our bodies are one-fifth carbon.
3. Carbon bonds easily to other elements to make fossil fuels, plastics, and the gas carbon dioxide (CO<sub>2</sub>) (we discuss carbon dioxide in detail below).

B. Examples of carbon in our environment

(If you have items that do and don't contain carbon on a desk or table, have students gather around so you can pass the items around as you discuss them.)

1. Carbon is in **living** things and **once-living** things, like plants, eggshells, seashells, pearls, wood and bones all contain carbon.
2. Carbon is in **nonliving** things like diamonds, graphite (pencil lead), some rocks, some gases, plastic, fossil fuels, carbonated water, and fizzy drinks.
3. Water (H<sub>2</sub>O), an aluminum can, a steel nail, table salt (NaCl), other pure metals, and some rocks don't contain carbon.
4. Carbon combines with oxygen to form a gas called carbon dioxide (CO<sub>2</sub>).
  - a. Humans and other animals breathe in oxygen and exhale carbon dioxide.
  - b. Plants take in carbon dioxide and release oxygen during photosynthesis. Plants need CO<sub>2</sub> to create energy, which they pass on to microbes in the soil in the form of sugars. They also provide energy to humans and animals that eat them.
  - c. Carbon dioxide traps heat in the atmosphere, which makes our planet warm and livable for us. But too much CO<sub>2</sub> can make the planet too warm, causing more severe weather events (like hurricanes, tornadoes, and torrential rains). Warmer temperatures can negatively affect living things: ice at the North Pole can melt, reducing polar bears' hunting grounds; coral reefs can expel algae and bleach; turtles' gender ratios can be affected; and birds' migration patterns can be altered.

C. Carbon Reservoirs

Besides being a part of all living things, carbon also cycles through the environment. Sometimes carbon changes forms and moves through the environment quickly, but other times it is stored in one place for a very long time. A place on Earth where carbon is stored is called a carbon reservoir.

We have four stations set up, each representing a different carbon reservoir. (Instructor, go to each station and discuss the causes and effects of carbon cycling through that particular reservoir.)

## ATMOSPHERE

**1. ATMOSPHERE** - carbon bonds with oxygen to make carbon dioxide (CO<sub>2</sub>) in the atmosphere

***Carbon dioxide in the atmosphere increases when people:***

- a. Burn wood (forest fires, campfires, in wood stoves, to clear land)
- b. Burn fossil fuels like gasoline, coal, oil & natural gas. These are made from the remains of ancient plants and animals that formed over millions of years. We burn fossil fuels when we travel in cars, buses, and planes, and to generate energy from power plants that burn coal, natural gas or oil.
- c. Manufacture plastics. Most plastics are made from hydrocarbons by extracting and refining raw materials like oil and gas. Additional carbon dioxide is released into the atmosphere from the burning of fossil fuels when plastic is manufactured.
- d. Manufacture products, especially new ones. Making products by recycling used items usually uses less energy, thus releasing less carbon dioxide into the atmosphere. For example, making aluminum from recycled cans uses 95% less energy than mining & using bauxite ore, the raw material for aluminum. The production of styrofoam (take-out containers and cups) is also very energy-intensive.
- e. Manufacture new clothes. The clothing industry is thought to be responsible for 10% of global carbon emissions, and that amount is expected to rise 50% in the next 5 years. About 2/3 of fabrics are derived from fossil fuels. Additionally, most clothes are manufactured in Asia and must be transported to the US, which requires the use of more fossil fuels and results in increased CO<sub>2</sub> emissions into the atmosphere.  
**Ask students: What is an alternative to buying a new pair of jeans (or any new item of clothing)?**
- f. Raise and consume meat. Livestock farming can increase carbon dioxide levels in the atmosphere through deforestation to increase rangeland, the application of chemicals, and the use of machinery in feed production.

***Carbon dioxide in the atmosphere increases when:***

- a. Plants absorb carbon dioxide for photosynthesis (more info about this at the PLANTS station)
- b. The ocean absorbs carbon dioxide (more info about this at the OCEAN station)
- c. Over a very long time (on the geological timescale), organic matter (from dead plants & marine organisms) is buried and transformed into fossil fuels, like coal, oil & natural gas. This sequesters carbon underground.

**2. OCEAN** - the ocean plays a crucial role in the carbon cycle. There is more carbon dioxide in the ocean than in the atmosphere!

- a. Carbon dioxide from the atmosphere **dissolves in ocean** water wherever air & water meet.

Besides carbon dioxide, ocean surface waters also absorb and release oxygen and other gases. Scientists believe that the ocean's absorption of carbon dioxide is slowing because it may be nearing saturation.

## OCEAN

## PLANTS

- b. Ocean plants (algae) & **phytoplankton** take in carbon dioxide & release oxygen, just like land plants. **Zooplankton** eat phytoplankton and release carbon dioxide, like other animals.
- c. Marine animals use carbon dissolved in the ocean to build their bones and shells, but **increased carbon dioxide in the ocean is making the ocean more acidic**. The acidity can hurt marine life because their shells can dissolve more easily.
- d. Plastic garbage in the ocean dissolves, adding more hydrocarbons to the ocean.
- e. The **deep ocean** stores 15-20 times more carbon than land plants and soil, making it the largest reservoir of carbon on Earth.

### 3. PLANTS - plants absorb carbon dioxide from the atmosphere. **Photosynthesis** is the process by which plants use sunlight and carbon dioxide to make energy.

- a. Some carbon (from the carbon dioxide) is stored in the plants' bodies and consumed by animals that eat the plant, providing energy for the animals.
- b. Plants release 1-40% of the carbon they take in (from carbon dioxide) through their roots. They release these carbohydrates, or sugars, in the soil to feed soil microbes, which in turn help make nutrients in the soil available for the plants.
- c. Factors such as moisture, sunlight, and temperature can influence a plant's rate of photosynthesis. The more ideal these conditions are, the higher the plant's photosynthesis rate will be, enabling it to release more carbon into the soil in the form of sugars for microbes.
- d. Plants release oxygen into the atmosphere during photosynthesis.

## SOIL

### 4. SOIL - soil is a significant carbon reservoir.

- a. Carbon is sequestered (stored) in soil by plants through photosynthesis and the release of sugars into the soil to feed soil microbes.
- b. Microbes in the soil and other decomposers need the carbon from plant exudates (sugars) to build their bodies. Thus, composting helps sequester carbon in the soil.
- c. Decomposing plants and leaves add some carbon to the soil and help protect it from excessive heat and erosion. Organic matter breaking down on the soil surface also helps shield microbes, allowing them to continue supporting plants' health. This is a good reason to leave decomposing plants and leaves on the soil instead of putting them in plastic bags and sending them to the landfill.
- d. Composting food and yard waste means a household generates less trash and makes fewer trips to the landfill. This helps lower the amount of carbon dioxide released into the air.
- e. Modern agricultural practices such as tilling, spraying chemical pesticides, applying synthetic fertilizers, and monocropping deplete the carbon stored in the soil. As a result of these practices, most of the carbon in the soil is released into the atmosphere.

## THE CARBON GAME

### II. THE CARBON GAME

- A. The Carbon Game focuses on the four Carbon Reservoir stations. Each of these stations has **supplies** we need for the game.
1. A sign indicating which reservoir the station represents (Atmosphere, Ocean, Plants, Soil)
  2. A bowl containing **10 beads**. Each bead represents a unit of carbon.
  3. A stack of **scenario cards**. During the first round, each station will have 15 blue cards and 5 green cards. During the second round, each station will have 15 green cards and 5 blue cards.
  4. A container labeled "DISCARD" for the used scenario cards.

**B. Objective** - The objective of the game is to work with a partner to carefully read each card and follow directions by going to the reservoir where the card directs you. You will then add or remove carbon beads to or from your shoelace, or move beads from one reservoir to another.

This isn't a race; it's a chance to see how daily human actions influence the way carbon moves through the environment and how that affects our world and our lives.

### C. The Carbon Game - Rules & Procedures

Instructor, explain rules 1-5 below, then demonstrate these steps for students. You can work with another student to show how each person in the pair can take on a role, such as the reader of the card or the person who removes and adds beads to the shoelace.

1. Students will work in pairs.
2. Each pair gets a shoelace with 15 carbon "beads."
3. To begin, each pair will take a card from any station and read the card carefully. It will describe an action and directions to either deposit or collect carbon beads from a particular reservoir.
4. Students will carefully untie one end of the shoelace to add or remove beads. At the station indicated by the card's directions, students will draw the next card and follow the instructions.
5. The class will play Round 1 until most pairs are out of beads.

#### 6. DEMONSTRATE for students how to play.

- a. Draw a card from any station.  
For example, it might say:  
"You're flying to Florida in a plane. Give 4 carbons to the atmosphere."
- b. Go to the atmosphere station and untie one end of your shoelace. With your partner's help, remove four beads and put them in the bead bowl at the ATMOSPHERE station.
- c. Put the card you just read in the "DISCARD" box. Take a card from the top of the pile of unused cards and read the directions.  
It might say:  
"You buy lettuce in a hard, plastic container, which uses fossil fuels. Give 2 carbons to the ocean."

## RULES & PROCEDURES

**PLAY  
ROUND 1**

- d. Go to the OCEAN station, remove 2 carbon beads from your shoelace, and put them in the bead bowl.
  - e. Put the card you just read in the "DISCARD" box. Then you would take a card from the top of the pile of unused cards and read the directions for your next turn.  
PLEASE NOTE: Students can put their used cards in any "Discard" box once they have read and understood the directions on the card. Some may be comfortable putting their cards in the "Discard" box right after reading them while others may want to wait until they have completed the instructions.
  - f. Hopefully the students get the gist by now and are ready to play!
7. Play Round 1. When most students are out of beads (after about 5-7 minutes), have all the pairs turn in their shoelaces and sit down.
  8. Ask for volunteers to count the total number of beads in each reservoir. **(Make sure they return the beads to each reservoir for the next round!)**
  9. At this time, you can also have other volunteers empty the DISCARD boxes and sort the scenario cards into two separate piles for blue and green cards. Then, they can count out 15 green cards and 5 blue cards for each station for Round 2.
  10. If needed, you can ask other student volunteers to re-string the shoelaces with 15 beads each and tie knots on both ends.
  11. Meanwhile, draw the table below on a blackboard or whiteboard. The table shows each station and how many beads were at each station before Round 1 began.
  12. As the students finish counting the number of beads at each station, record how many carbon beads were in each reservoir after Round 1.

STATION	#Carbon Beads at Beginning	#Carbon Beads after Round 1	#Carbon Beads after Round 2
Atmosphere	10		
Ocean	10		
Plants	10		
Soil	10		

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**PLAY  
ROUND 2**

13. Once all the tasks are finished and you have the students' attention, ask them:
  - a. What human activities added carbon to the atmosphere and ocean?
  - b. What happens as the amount of carbon dioxide in the atmosphere increases?
  - c. What happens as the amount of carbon dioxide in the ocean increases?
  - d. What activities removed carbon from the atmosphere and ocean?
  - e. What activities added carbon to the plants and soil?
- 14. Leave the beads in the reservoirs** and pass out a shoelace with 15 carbon beads to each pair of students for Round 2. (Make sure the DISCARD boxes have been emptied and that each station now has 15 green cards and 5 blue cards.)
15. Tell students to begin Round 2, playing the same way they did in Round 1. This round will last 5-7 minutes, or until one of the stations and/or several pairs of students run out of beads.
16. After Round 2, have the students turn in their shoelaces and sit down. Ask volunteers to count the number of beads at each station and record the new numbers on the table.
17. Ask students:
  - a. Compare the amount of carbon in the atmosphere, ocean, plants and soil in each round.
  - b. What made the carbon increase and decrease in each reservoir in each round?
  - c. What kinds of activities put more carbon in the plants and soil? (This is where carbon should be stored!)
  - d. What happens if there is too much carbon dioxide in the air? In the ocean?

**CONCLUSION**

- III. Conclusion** - What are some things you and I could do to put less carbon in the atmosphere and ocean, and more in the plants and soil?