

# The Carbon Cycle Game

Time Required: 30 minutes

Materials/Space Required:

- Carbon Cycle Reservoir Cards (7)
- Dice (6)
- Traveling Carbon Passport Sheets (1 per student)
- Felt markers or pencil crayons for each reservoir station (different colours for each station is visually effective)
- This game can be played in or out of doors. However, the more space provided the more fun the game!!

Objectives

- To embody the natural cycle of carbon through all its stages in the environment.
- To illustrate the concept of a *carbon balance* and how the burning of fossil fuels has increased the amount of carbon now present in the carbon cycle, upsetting the balance.

Set Up

- Place the seven reservoir cards around the room.
- At each station place a die and some markers/crayons.

Format

In Class:

Introduce the seven carbon cycle reservoirs: atmosphere, land plants, soils, surface oceans, marine life, deep oceans, and the deep earth. Draw a diagram on the board and discuss how a carbon atom may be transformed and travel from one reservoir to another.

In the game, 30% of the class will start at the “secret station” (deep earth) which represents the observed 30% increase in atmospheric CO<sub>2</sub> over the past 150 years. This station does not need a die because no other reservoir will lead CO<sub>2</sub> back there during the game. This illustrates the imbalance created in the carbon cycle by the burning of fossil fuels.

Ready to Play:

Direct groups of children to start at different reservoir stations around the room. 30% of the class will start at a “SECRET STATION” (deep earth) to be located with the teacher; read them the card and send them on their way to the atmosphere reservoir.

Each child will mark their **starting station** in the top left box provided on their *traveling carbon passport*. They must then **roll the die** and read the corresponding instructions to find out where they will move to next! In the directions on the card it explains **how they traveled**. (The students should take note of how they traveled along their journey as they go, or they can fill it in later –it’s up to you!) The

children must then record **where they went** in the next box to complete Trip #1 before moving on to the next station!

When the children have completed all eight trips they can have a seat and wait for their classmates to finish. You can have them sketch the diagram from the board on the reverse side of their passport, and **trace their journey** as they wait.

### **Evaluation**

Once everyone is finished ask for a few volunteers to call out their journey to be traced on the board. It is fun to see how everyone's journey is different and how different reservoirs were visited more than once. This is a good time to reinforce how each reservoir is connect and how CO<sub>2</sub> travels between them (this is all explained on the cards provided).

Key concepts and questions to ask the class:

- Normally when we learn cycles they are drawn as circles. **Did you travel in a circle or did you jump randomly back and forth between reservoirs?** This is a more accurate depiction of natural cycles in nature.
- **What was the "secret station"?! Did anyone travel to *deep earth* in this game? Why not?** Have one of the students from the deep earth station explain how they left the deep earth, and why they think they never got back there during the game (specific information provided on the card).
- **So what happens to the carbon cycle with all that extra CO<sub>2</sub>?** Well the carbon cycle is *no longer in balance*, and the extra CO<sub>2</sub> accumulates in the atmosphere as a greenhouse gas. This heats up the atmosphere and creates global warming!

RESERVOIR	POTENTIAL ROUTES
<p>You've arrived at the: <b>Atmosphere</b></p> <p><i>Stamp your passport and then roll the die to see where you will travel next!</i></p>	<ul style="list-style-type: none"> <li>• <u>If your die reads: 1 or 2</u> You have been taken out of the atmosphere by a plant as it used the Sun's energy to make the nutrition it needs (a process called photosynthesis). You are now one of the building blocks that make up a <b>land plant</b>.</li> <li>• <u>If your die reads: 3 or 4</u> You diffuse from the atmosphere and become a part of the <b>surface ocean</b>.</li> <li>• <u>If your die reads: 5 or 6</u> A tiny marine organism called phytoplankton has taken you in to make the nutrition it needs through a process called photosynthesis. Yikes! Larger marine life has eaten you! You are now within <b>marine life!!</b></li> </ul>



RESERVOIR	POTENTIAL ROUTES
<p>You've arrived at: <b>Soils</b></p> <p><i>Stamp your passport and then roll the die to see where you will travel next!</i></p>	<ul style="list-style-type: none"> <li>• <u>If your die reads: 1 or 2</u> You dissolve into the ground water, find your way down a river, and wash into the <b>surface ocean!</b></li> <li>• <u>If your die reads: 3 or 4</u> You are just the sort of carbon that plants need to live. You are now within a <b>land plant!</b></li> <li>• <u>If your die reads: 5 or 6</u> You've now decomposed into soil. Soil is also made of inorganic parts such as sand, silt, and clay. Soils store about 3% of Earth's carbon. As bacteria and fungi breakdown the detritus (decomposing plants and animals), carbon is sent into the <b>atmosphere</b>.</li> </ul>



RESERVOIR	POTENTIAL ROUTES
<p>You've arrived at the: <b>Surface Ocean</b></p> <p><i>Stamp your passport and then roll the die to see where you will travel next!</i></p>	<ul style="list-style-type: none"> <li>• <u>If your die reads: 1 or 2</u> A tiny marine organism called phytoplankton has taken you in to make the nutrition it needs through a process called photosynthesis. Yikes! Larger marine life has eaten you! You are now within <b>marine life!</b> OR You grow with the organism</li> <li>• <u>If your die reads: 3 or 4</u> Look Out! Water is on the move. You tumble around and this circulating water from the surface ocean has released you into the <b>deep ocean</b>. The deep ocean holds more than 65% of the Earth's carbon.</li> <li>• <u>If your die reads 5 or 6</u> The surface temperature of the ocean has increased causing you to be released into the <b>atmosphere!</b> Warmer water cannot hold as much carbon dioxide.</li> </ul>



RESERVOIR	POTENTIAL ROUTES
<p>You've arrived at: <b>Marine Life</b></p> <p><i>Stamp your passport and then roll the die to see where you will travel next!</i></p>	<ul style="list-style-type: none"> <li>• <u>If your die reads: 1 or 2</u> You a part of a clam's shell that lives in the <b>surface ocean</b></li> <li>• <u>If your die reads: 3 or 4</u> The marine life you are within has died. Go to <b>dead plants and marine life</b>.</li> <li>• <u>If your die reads: 5 or 6</u> Congratulations! You didn't get eaten. You died a natural death and floated all the way down to the <b>deep ocean</b>. Where you will stay for hundreds of years.</li> </ul>

RESERVOIR	POTENTIAL ROUTES
<p>You've arrived at: <b>Deep Ocean</b></p> <p><i>Stamp your passport and then roll the die to see where you will travel next!</i></p>	<ul style="list-style-type: none"> <li>• <u>If your die reads: Odd numbers 1, 3, or 5</u> You're way down deep and hard to see. I'm afraid you are a part of the dead marine life on the ocean floor. Go to <b>dead plants and marine life</b>.</li> <li>• <u>If your die reads: Even numbers 2, 4, or 6</u> You have been whirling and tumbling around and the circulating water from the deep ocean has released you into the surface <b>ocean!</b></li> </ul>

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RESERVOIR	POTENTIAL ROUTES
<p>You've arrived at: <b>Dead plants and marine life</b></p> <p><i>Stamp your passport and then roll the die to see where you will travel next!</i></p>	<ul style="list-style-type: none"> <li>• <u>If your die reads: 1 or 2</u> Dead plant or marine life contains nutrients to grow farmer's crops. You're decomposing body has been carried to a farmer's field and placed on his soil. You're now a part of the soil called detritus. Detritus is decomposing plants and animals. Go to <b>soils</b>.</li> <li>• <u>If your die reads: 3 or 4</u> You are decomposed marine life or a dead plant and you've found your way to the ocean and become dissolved in the <b>surface ocean!</b></li> <li>• <u>If your die reads: 5 or 6</u> Forest Fire! The woods you were nearby are burnt and you have been released into the <b>atmosphere</b>.</li> </ul>

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RESERVOIR	POTENTIAL ROUTES
<p>You've arrived at: <b>Land plants</b></p> <p><i>Stamp your passport and then roll the die to see where you will travel next!</i></p>	<ul style="list-style-type: none"> <li>• <u>If your die reads: Odd numbers (1, 3, or 5)</u> As more carbon dioxide is added to our atmosphere, plants will be able to grow faster, but plants also release carbon back to the <b>atmosphere</b> by respiration or decomposition.</li> <li>• <u>If your die reads: Even numbers (2, 4, or 6)</u> We are afraid to say that the plant you were in has died Go to <b>dead plants and marine life</b>.</li> </ul>

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Give about 30% of the class the sheet below (for a class of 30 that's 9 students) to represent the number of new carbon dioxide molecules found in the atmosphere since the discovery of fossil fuels.

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<b>You are a Carbon Atom</b>
<p>For millions of years you were underground in fossil fuels. Now, you have been released into the atmosphere as humans <b>burn fuels in vehicles and factories</b>.</p> <p>In this game, you will travel the carbon cycle. While you are here, little carbon atom, you will be stuck to two atoms of oxygen in a greenhouse gas called carbon dioxide. Only a small amount (0.04%) of the atmosphere is made of carbon dioxide. Because of burning fossil fuels the amount has increased about 30% in the past 150 years. More carbon dioxide in our atmosphere makes our planet warmer.</p> <p>Your start location will be different from the rest of the class. Try to keep it a secret. <b>REMEMBER TO PLACE THE DEEP EARTH STAMP ON YOUR START LOCATION and then go to the ATMOSPHERE STATION.</b></p> <p>Will you make it back to the <b>DEEP EARTH</b> station???</p>

# TRAVELLING CARBON PASSPORT

Name: \_\_\_\_\_

Directions:

1. Stamp your start location in the space below.

<p>Start location</p>   <p><i>Stamp above</i></p>
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2. Roll the die to find out where to go next. Write *How I traveled* in the Trip #1 box below (see example at right).

3. Go to that location in the room and stamp the Trip#1 *Where I went* box. Then, roll the die to find out where to go next.

Guess what! In this game you are a carbon atom. You are going to travel the carbon cycle stopping in many exciting locations - some of which you probably never have been to before.

For each stop along your journey, remember to record where you went and how you got there.

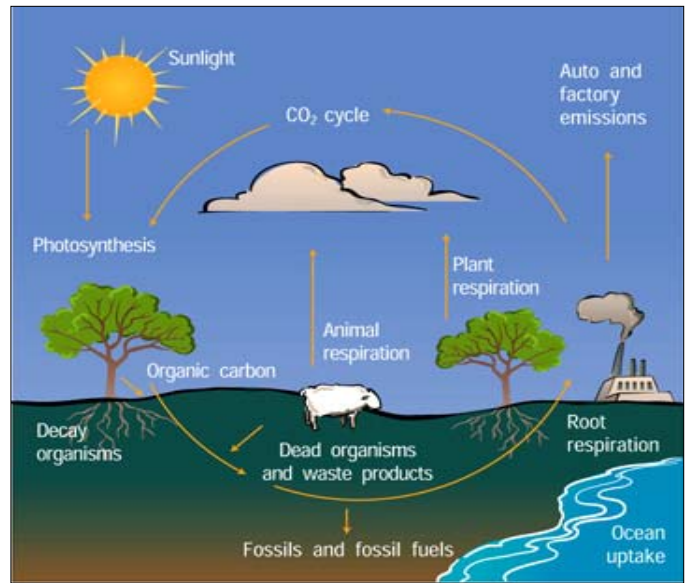
Here's an example of how to fill out each stop along the way:

Trip#1: How I traveled: Decomposed into soil	Where I went:  <i>stamp</i>
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Trip #1: How I traveled:    	Where I went:    <p style="text-align: center;"><i>Stamp above</i></p>	Trip #5: How I traveled:    	Where I went:    <p style="text-align: center;"><i>Stamp above</i></p>
Trip #2: How I traveled:    	Where I went:    <p style="text-align: center;"><i>Stamp above</i></p>	Trip #6: How I traveled:    	Where I went:    <p style="text-align: center;"><i>Stamp above</i></p>
Trip #3: How I traveled:    	Where I went:    <p style="text-align: center;"><i>Stamp above</i></p>	Trip #7: How I traveled:    	Where I went:    <p style="text-align: center;"><i>Stamp above</i></p>
Trip #4: How I traveled:    	Where I went:    <p style="text-align: center;"><i>Stamp above</i></p>	Trip #8: How I traveled:    	Where I went:    <p style="text-align: center;"><i>Stamp above</i></p>

**FYI: Factual Tidbits to be used in the discussion after the game has been played.**

- Soils take carbon dioxide out of the atmosphere (store about 3%), but they also release it to the atmosphere! In fact, soils release more carbon dioxide into the atmosphere than humans do. (permafrost melting releases even more methane)
- If atmospheric carbon dioxide levels continue to increase, plants will take in more carbon dioxide and grow faster.
- The ocean absorbs more carbon dioxide from the atmosphere than the land does. The surface ocean takes in approximately 90 Gigatons of carbon per year. Cold water absorbs carbon faster than warm water. A great simple experiment that students can try is with 2 pop bottles. Put one in the fridge and one in the sun. Open both at the same time! Which one releases more carbon dioxide? The one that "fizzes" more. This is also why warm pop goes "flat" sooner! It can't store as much carbon dioxide, just like our oceans as they heat up!
- The deep ocean gets carbon from circulation with the surface ocean and dead and decaying marine life. When carbon gets to the deep ocean, it usually stays there for hundreds of years before moving on. The deep ocean holds more than 65% of the Earth's carbon.
- There has been a 30% increase in the amount of carbon dioxide in the atmosphere over the past 150 years, about the start of the Industrial Revolution.
- The "carbon cycle" is by no means cyclical. Carbon moves back & forth between various reservoirs.



### Reservoir Times

(The time an average carbon molecule spends in a given reservoir)

- Atmosphere = 4 years
  - Biosphere (terrestrial plant & animal) = 11 yrs
  - Surface Ocean = 385 yrs
  - Deep Ocean = 100,000 yrs
  - Crust & Sedimentary Rock = 324 million years
- Tiny marine organisms called phytoplankton take in carbon to make the nutrition they need through a process called photosynthesis. The phytoplankton are eaten by larger marine life. Marine life cannot survive without carbon, but high levels of carbon dissolved in ocean waters are harmful to marine organisms such as algae, mollusks and corals. Too much carbon makes the seawater too acidic for clams, snails, & other sea animals and prevents them from growing their shells.

For a more in depth analysis of the Global Carbon Cycle see:

[http://www.globalchange.umich.edu/globalchange1/current/lectures/kling/carbon\\_cycle/carbon\\_cycle\\_new.html](http://www.globalchange.umich.edu/globalchange1/current/lectures/kling/carbon_cycle/carbon_cycle_new.html)

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