

The Carbon Cycle Game

(Adapted by Jennifer Ceven from "The Incredible Journey," *Project Wet*)

Please credit the author, Jennifer Ceven, Grade 6 Science Teacher, when using this lesson

Summary:

By rolling a die, students will simulate a molecule of carbon's movement throughout various sinks and sources within the carbon cycle.

Objectives:

- Students will describe the movement of carbon within the carbon cycle.
- Students will classify elements of the carbon cycle as sinks or sources.
- Students will evaluate the relative timing of movement through various sinks and sources.

Materials:

- 7 Dice
- 7 Station Signs
- 7 Station Movement Directions for Before Human Interference
- 7 Station Movement Directions for After Human Interference
- Data record sheets for each student

Background:

The movement of carbon through various aspects of the natural environment is the focus of much scientific research. Global warming and climate change can be attributed to the increased amount of heat-trapping gases, such as carbon dioxide. Students must develop an understanding of how carbon moves through the environment in order to appreciate the complexity of developing solutions to address problems associated with climate change. In addition, since anthropogenic influences impact how much carbon is reintroduced to the active carbon cycle, students should recognize that human actions negatively affect the environment.

Warm-Up:

- Discuss where carbon can be found on Earth.
- Discuss the role of carbon in each of the places identified.

The Activity:

1. Tell students that they are going to be carbon atoms moving through the carbon cycle.
2. Categorize the places carbon can be found into these stations: Atmosphere, Plants, Animals, Soil, Ocean, Deep Ocean, and Fossil Fuels. Point out the areas of the room that are labeled with each station and contain the directions for movement from that station.
3. Explain that for the first round, they will be simulating the carbon cycle before human disturbance, about 6,000 years ago.

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4. Assign students to each station randomly and evenly. Have students identify the different places carbon could go from that given station. Discuss the processes that allow for the transfer of carbon between stations and identify sources and sinks of carbon.
5. Students should make a line and roll the die individually to follow the directions for movement from (or retention at) each station. Remind them that they are representing atoms of carbon moving through the carbon cycle and that they should record their movements on the data sheet.
6. Allow only a few minutes for this round of the game. Students will quickly realize the routine movements (or non-movements) in the “natural” carbon cycle. On a whiteboard or chart paper, record the number of carbon atoms (students) at each station.
7. Replace the Station Movement cards with the After Human Interference cards. Have the students start from their present station and continue playing the game. Continue the simulation for a sufficient enough time to eliminate all of the carbon atoms from the Fossil Fuels station.

Wrap-Up and Action Plan:

- Have students compare the movement of carbon before and after human interference.
- Be sure to discuss what has happened to the Fossil Fuels as well as any changes in the number of atoms in certain stations. Refer back to the carbon atom location record from the end of “Before Human Interference.”
- Discuss the effects that these differences could have on climate change.
- Ask if there are any actions humans could take to make the carbon cycle return to a more natural state. Discuss the actions that returned carbon to plants or sequestered carbon in sinks.
- Develop an action plan that students could take in their everyday lives to reduce anthropogenic disturbances to the carbon cycle.

Assessment:

- Rate students’ understanding on their responses from class or group discussions.
- Assign a follow-up activity:
 - Role-play the motion of carbon throughout the carbon cycle.
 - Write a process-analysis essay on the movement of carbon throughout the carbon cycle.
 - Write a comparison-contrast essay on the carbon cycle before and since human interference.
 - Create a poster that encourages people to participate in actions that would be more climate-friendly.
 - Teach the game to a younger child.

The Carbon Cycle

REFERENCE PAGE

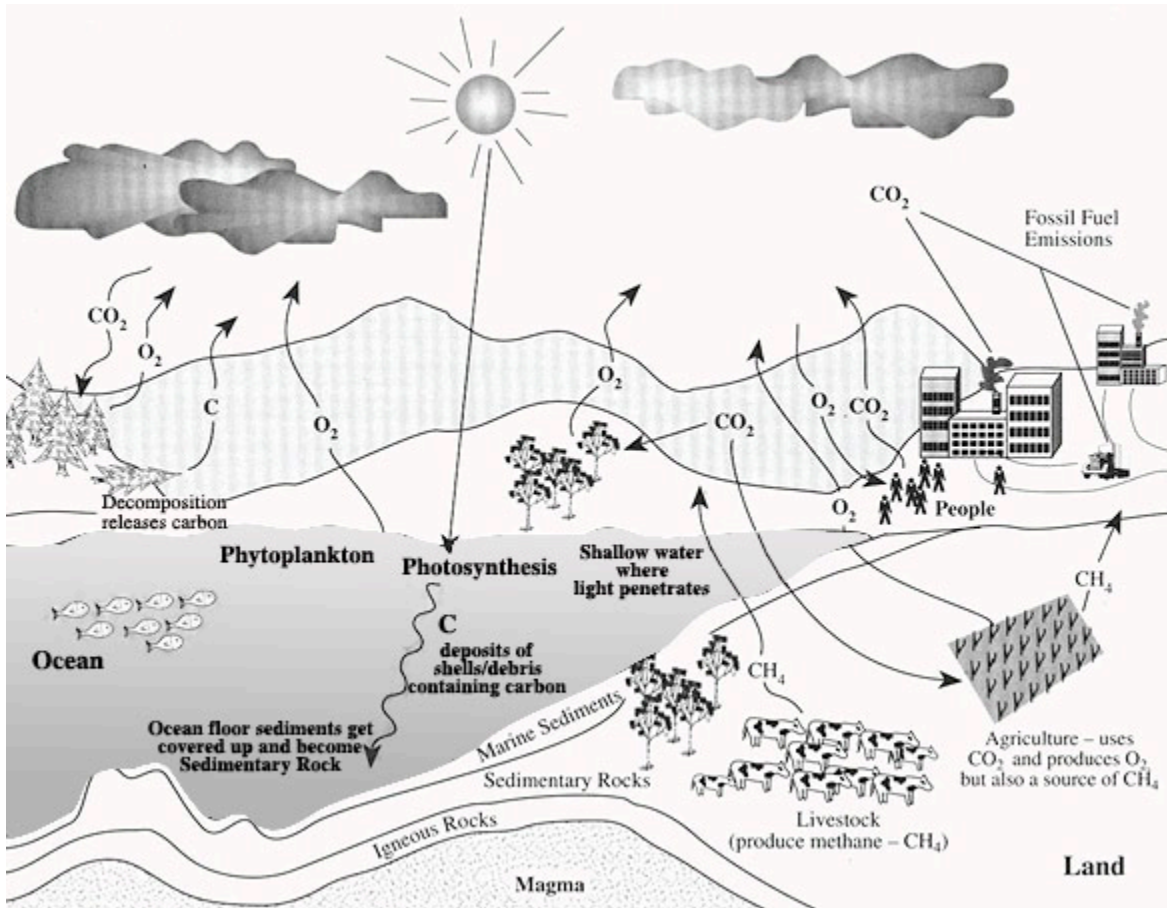


Image Source: http://www.bigelow.org/foodweb/carbon_cycle.jpg

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The Carbon Cycle
DATA RECORD SHEET

Record the places you have traveled as a carbon molecule before human interference. You may or may not fill up all the spaces.

Student's Name: _____

BEFORE HUMAN INTERFERENCE

	Station Stop	What Happens	Destination
1.	_____	_____	_____
2.	_____	_____	_____
3.	_____	_____	_____
4.	_____	_____	_____
5.	_____	_____	_____
6.	_____	_____	_____

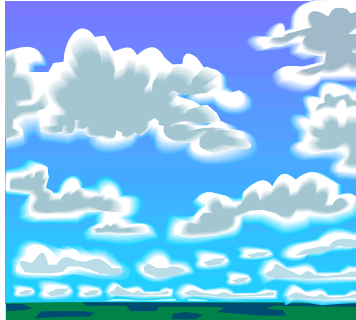
AFTER HUMAN INTERFERENCE

	Station Stop	What Happens	Destination
1.	_____	_____	_____
2.	_____	_____	_____
3.	_____	_____	_____
4.	_____	_____	_____
5.	_____	_____	_____
6.	_____	_____	_____
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9.	_____	_____	_____
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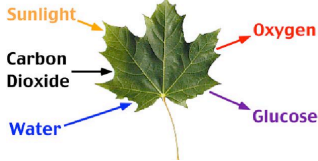
The Natural Carbon Cycle

Before Human Interference, About 6,000 Years Ago

THE ATMOSPHERE



You are currently a molecule of carbon dioxide in the atmosphere. The atmosphere is a blanket of gases that surround Earth. Most of these gases, including carbon dioxide, act like a greenhouse. They allow light to pass toward Earth, but they trap heat before it leaves Earth's atmosphere. Therefore, these gases are called "Heat Trapping Gases." They are very important to life on Earth, but too much of a good thing isn't always a good thing...

If you roll...	Then you ...
1	Stay in the atmosphere. Much of the carbon dioxide in the atmosphere circulates through the atmosphere and does not interact with the other sources or sinks of carbon.
2	Go to plant. You are used by a plant in photosynthesis. The carbon you provide can be used to create the plant's structures. 
3	Stay in the atmosphere. Much of the carbon dioxide in the atmosphere circulates through the atmosphere and does not interact with the other sources or sinks of carbon.
4	Stay in the atmosphere. Much of the carbon dioxide in the atmosphere circulates through the atmosphere and does not interact with the other sources or sinks of carbon.
5	Go to surface ocean. About 12% of carbon in the atmosphere is mixed into the shallow ocean. This carbon dioxide can be used by photosynthetic algae or stored in the water.
6	Go to plant. You are used by a plant in photosynthesis. The carbon you provide can be used to create the plant's structures.



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**The Natural Carbon Cycle
Before Human Interference, About 6,000 Years Ago**

PLANTS



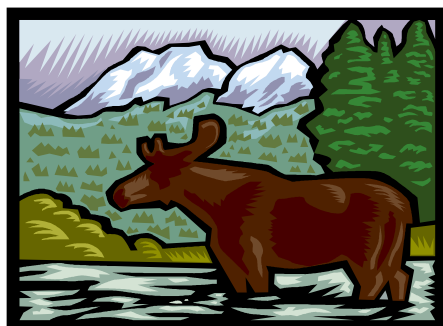
You are currently a carbon compound in the structure of the plant. The plant has taken you in from the air and has created carbohydrates through the process of photosynthesis. Some of the carbon is emitted back to the atmosphere from the plant's leaves through respiration at times when the plant is not photosynthesizing. Sometimes, carbon is stored as carbohydrates within the structure of the plant.

If you roll...	Then you ...
1	<p>Go to soil. The tree shed its leaves, and you are an atom of carbon from those dead leaves that enters the soil.</p> 
2	<p>Stay in plant. You are a carbon atom in the tree's trunk, a part that will not likely be removed or destroyed.</p>
3	<p>Go to animal. The leaves and berries that the plant produced contain your carbon atom. You will be processed into structures in the animal that consumed you.</p> 
4	<p>Stay in plant. You are a carbon atom in the tree's roots, a part that will not likely be removed or destroyed.</p>
5	<p>Stay in plant. You are a carbon atom in the tree's branches, a part that will not likely be removed or destroyed.</p>
6	<p>Stay in plant. You are a carbon atom in the tree's trunk, a part that will not likely be removed or destroyed.</p>



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**The Natural Carbon Cycle
Before Human Interference, About 6,000 Years Ago**

ANIMALS

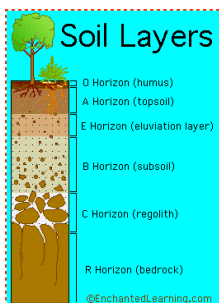


You are currently a molecule of carbohydrate in an animal. You have been consumed by an animal to help it grow and develop. The animal can either store you away in its body structures, or release you back to the atmosphere as it uses the carbohydrate you're stored in as energy.




If you roll...	Then you ...
1	Stay in animal. You are consumed by a predator animal that has a long life. The carbon atom is stored as fat in the animal.
2	Go to soil. The animal that consumed you died and your carbon atom is returned to the soil. 
3	Go to atmosphere. The animal that consumed you respired (breathed) you out as carbon dioxide.
4	Stay in animal. You are consumed by a vulnerable prey animal that is, in turn, consumed by a predator animal. You are stored as protein in the muscles of the predator. 
5	Go to atmosphere. The animal that consumed you respired (breathed) you out as carbon dioxide.
6	Go to atmosphere. The animal that consumed you respired (breathed) you out as carbon dioxide.

**The Natural Carbon Cycle
Before Human Interference, About 6,000 Years Ago**

SOIL

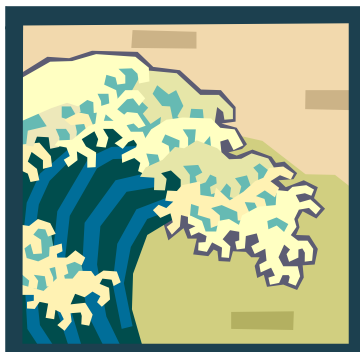


You are currently a molecule of carbon dioxide in the soil. Once you are here, you generally do not move around too much and are stored away. If you're stored long enough, you can join together with other carbon molecules to create fossil fuels.



If you roll...	Then you ...
1	Stay in the soil. Much of the carbon in the soil is stored and does not interact with the other sources or sinks of carbon.
2	Go to plant. You are used by a plant in photosynthesis. The carbon you provide can be used to create the plant's structures. 
3	Go to fossil fuels. Your carbon molecule has been in the soil so long that it binds together with other carbon molecules to create fossil fuels. 
4	Go to the atmosphere. A tiny decomposer uses your carbon atom as it breaks down the detritus in the soil.
5	Stay in the soil. Much of the carbon in the soil is stored and does not interact with the other sources or sinks of carbon.
6	Go to fossil fuels. Your carbon molecule has been in the soil so long that it binds together with other carbon molecules to create fossil fuels. 

The Natural Carbon Cycle
Before Human Interference, About 6,000 Years Ago

SURFACE OCEAN



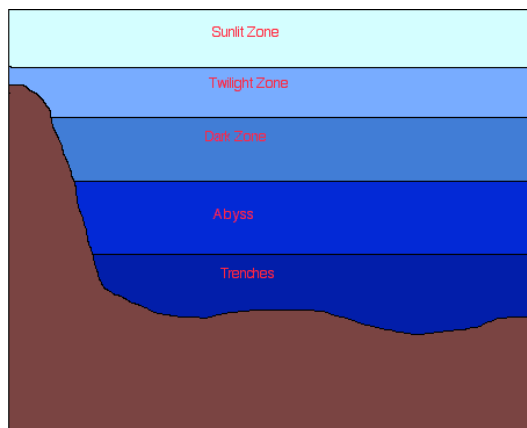
You are currently a molecule of carbon dioxide in the surface ocean. The surface ocean mixes around due to ocean currents, but does not mix well with the deeper ocean. Most carbon that enters the surface ocean remains mixed into the surface ocean waters, but can move to different sources or sinks.

If you roll...	Then you ...
1	<p>Go to deep ocean. Your carbon atom was part of an ocean organism that has died and has sunk to the bottom of the ocean.</p> 
2	<p>Stay in the surface ocean. Much of the carbon dioxide in the ocean circulates through the surface ocean and does not interact with the other sources or sinks of carbon.</p>
3	<p>Go to deep ocean. Your carbon atom was part of an ocean organism that has died and has sunk to the bottom of the ocean.</p> 
4	<p>Stay in the surface ocean. Much of the carbon dioxide in the ocean circulates through the surface ocean and does not interact with the other sources or sinks of carbon.</p>
5	<p>Go to the atmosphere. Your carbon dioxide atom is used by organisms in the water for respiration.</p>
6	<p>Go to the atmosphere. Your carbon dioxide atom is used by organisms in the water for respiration.</p>

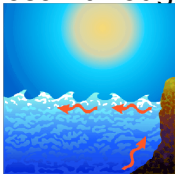
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The Natural Carbon Cycle
Before Human Interference, About 6,000 Years Ago

DEEP OCEAN



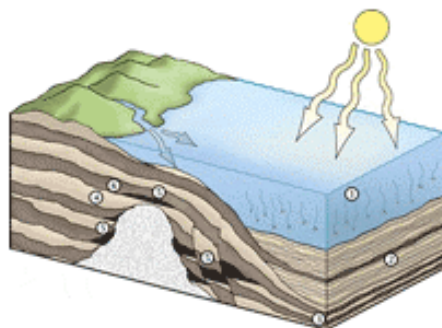
You are currently an atom of carbon in the deep ocean. The deep ocean has little interaction with other parts of the carbon cycle. However, it is an important carbon sink within the cycle.

If you roll...	Then you ...
1	Stay in the deep ocean. Much of the carbon dioxide in the deep ocean circulates through the ocean and does not interact with the other sources or sinks of carbon.
2	Stay in the deep ocean. Much of the carbon dioxide in the deep ocean circulates through the ocean and does not interact with the other sources or sinks of carbon.
3	Go to surface ocean. Some carbon dioxide in the deep ocean moves to the surface ocean through the process of upwelling. <div style="text-align: center;">  </div>
4	Go to surface ocean. Some carbon dioxide in the deep ocean moves to the surface ocean through the process of upwelling.
5	Go to surface ocean. Some carbon dioxide in the deep ocean moves to the surface ocean through the process of upwelling.
6	Go to animal. An organism in the water has taken you up as food in the deep ocean.

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**The Natural Carbon Cycle
Before Human Interference, About 6,000 Years Ago**

FOSSIL FUELS



You are currently an atom of carbon synthesized with other atoms in the soil. Fossil fuels are a rich source of energy that has been created from carbon that has been stored for many millions of years. Since this carbon has been stored for millions of years, it has little effect on the carbon cycle.

If you roll...	Then you ...
1	Stay in the fossil fuels. All of the carbon in fossil fuels is accumulated.
2	Stay in the fossil fuels. All of the carbon in fossil fuels is accumulated.
3	Stay in the fossil fuels. All of the carbon in fossil fuels is accumulated.
4	Stay in the fossil fuels. All of the carbon in fossil fuels is accumulated.
5	Stay in the fossil fuels. All of the carbon in fossil fuels is accumulated.
6	Stay in the fossil fuels. All of the carbon in fossil fuels is accumulated.

The Carbon Cycle
After Human Interference, Present Day
THE ATMOSPHERE



You are currently a molecule of carbon dioxide in the atmosphere. The atmosphere is a blanket of gases that surround Earth. Most of these gases, including carbon dioxide, act like a greenhouse. They allow light to pass toward Earth, but they trap heat before it leaves Earth's atmosphere. Therefore, these gases are called "Heat Trapping Gases." They are very important to life on Earth, but too much of a good thing isn't always a good thing...



If you roll...	Then you ...
1	Stay in the atmosphere. Much of the carbon dioxide in the atmosphere circulates through the atmosphere and does not interact with the other sources or sinks of carbon.
2	Go to plant. You are used by a plant in photosynthesis. The carbon you provide can be used to create the plant's structures. <div style="text-align: center;"> </div>
3	Stay in the atmosphere. Much of the carbon dioxide in the atmosphere circulates through the atmosphere and does not interact with the other sources or sinks of carbon.
4	Stay in the atmosphere. Much of the carbon dioxide in the atmosphere circulates through the atmosphere and does not interact with the other sources or sinks of carbon.
5	Go to surface ocean. About 12% of carbon in the atmosphere is mixed into the shallow ocean. This carbon dioxide can be used by photosynthetic algae or stored in the water.
6	Go to plant. You are used by a plant in photosynthesis. The carbon you provide can be used to create the plant's structures.

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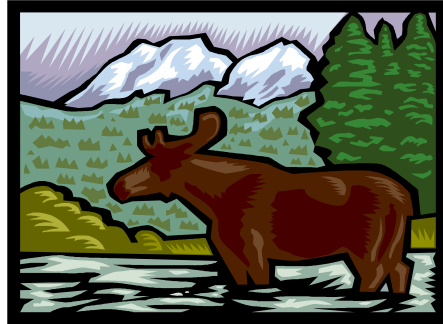
The Carbon Cycle
After Human Interference, Present Day
PLANTS





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If you roll...	Then you ...
1	Go to soil. The tree shed its leaves, and you are an atom of carbon from those dead leaves that enters the soil. 
2	Stay in plant. You are a carbon atom in the tree's trunk, a part that will not likely be removed or destroyed.
3	Go to animal. The leaves and berries that the plant produced contain your carbon atom. You will be processed into structures in the animal that consumed you. 
4	Go to atmosphere. Humans have cut down the tree that you are part of and have used it to create lumber. You were part of the excess that was burned.
5	Stay in plant. You are a carbon atom in the tree's branches, a part that will not likely be removed or destroyed.
6	Go to soil. Humans have cut down the tree that you lived in and left the part of the stump that you were in to rot in the soil.

The Carbon Cycle
After Human Interference, Present Day
ANIMALS

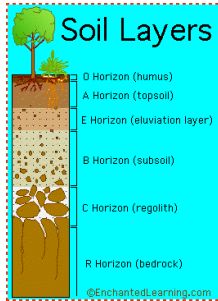


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2	Go to soil. The animal that consumed you died and your carbon atom is returned to the soil. 
3	Go to atmosphere. The animal that consumed you respired (breathed) you out as carbon dioxide.
4	Stay in animal. You are consumed by a vulnerable prey animal that is, in turn, consumed by a predator animal. You are stored as protein in the muscles of the predator. 
5	Go to atmosphere. The animal that consumed you respired (breathed) you out as carbon dioxide.
6	Go to atmosphere. The animal that consumed you respired (breathed) you out as carbon dioxide.

The Carbon Cycle After Human Interference, Present Day

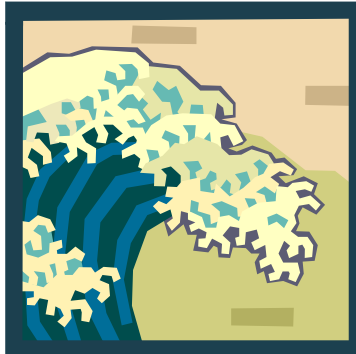
SOIL





You are currently a molecule of carbon dioxide in the soil. Once you are here, you generally do not move around too much and are stored away. If you're stored long enough, you can join together with other carbon molecules to create fossil fuels.

If you roll...	Then you ...
1	Stay in the soil. Much of the carbon in the soil is stored and does not interact with the other sources or sinks of carbon.
2	Go to plant. You are used by a plant in photosynthesis. The carbon you provide can be used to create the plant's structures. 
3	Go to fossil fuels. Your carbon molecule has been in the soil so long that it binds together with other carbon molecules to create fossil fuels. 
4	Go to the atmosphere. A tiny decomposer uses your carbon atom as it breaks down the detritus in the soil.
5	Stay in the soil. Much of the carbon in the soil is stored and does not interact with the other sources or sinks of carbon.
6	Go to the atmosphere. A tiny decomposer uses your carbon atom as it breaks down the detritus in the soil.

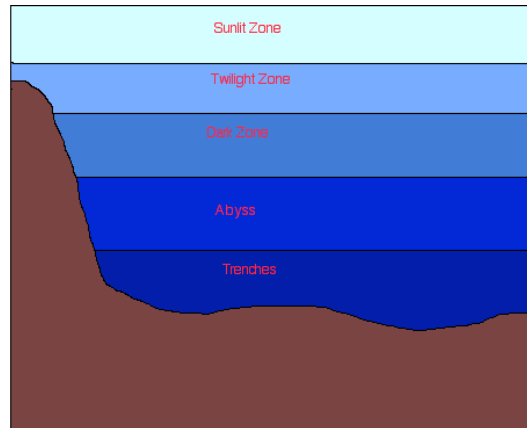
The Carbon Cycle
After Human Interference, Present Day
SURFACE OCEAN



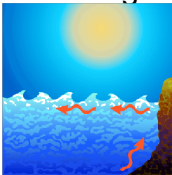
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If you roll...	Then you ...
1	Go to deep ocean. Your carbon atom was part of an ocean organism that has died and has sunk to the bottom of the ocean. 
2	Stay in the surface ocean. Much of the carbon dioxide in the ocean circulates through the surface ocean and does not interact with the other sources or sinks of carbon.
3	Go to deep ocean. Your carbon atom was part of an ocean organism that has died and has sunk to the bottom of the ocean. 
4	Stay in the surface ocean. Much of the carbon dioxide in the ocean circulates through the surface ocean and does not interact with the other sources or sinks of carbon.
5	Go to the atmosphere. Your carbon dioxide atom is used by organisms in the water for respiration.
6	Go to the atmosphere. Your carbon dioxide atom is used by organisms in the water for respiration.

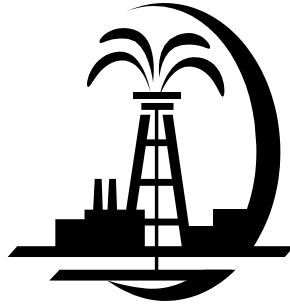
The Carbon Cycle
After Human Interference, Present Day
DEEP OCEAN



You are currently an atom of carbon in the deep ocean. The deep ocean has little interaction with other parts of the carbon cycle. However, it is an important carbon sink within the cycle.

If you roll...	Then you ...
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2	Stay in the deep ocean. Much of the carbon dioxide in the deep ocean circulates through the ocean and does not interact with the other sources or sinks of carbon.
3	Go to surface ocean. Some carbon dioxide in the deep ocean moves to the surface ocean through the process of upwelling. <div style="text-align: center;">  </div>
4	Go to surface ocean. Some carbon dioxide in the deep ocean moves to the surface ocean through the process of upwelling.
5	Go to surface ocean. Some carbon dioxide in the deep ocean moves to the surface ocean through the process of upwelling.
6	Go to animal. An organism in the water has taken you up as food in the deep ocean.

The Carbon Cycle
After Human Interference, Present Day
FOSSIL FUELS



You are currently an atom of carbon synthesized with other atoms in the soil. Fossil fuels are a rich source of energy that has been created from carbon that has been stored for many millions of years. Since this carbon has been stored for millions of years, it has little effect on the carbon cycle. That is, until humans disrupt the cycle...

If you roll...	Then you ...
1	Go to atmosphere. Humans have pumped the fuel that you are part of out of the ground and have used it to power their SUVs. You are emitted as a waste from the tailpipe.
2	Go to plants. Humans have pumped the fuel that you are part of out of the ground and have used it to create power at a power plant. You are emitted as dust from the stack pipe.
3	Go to atmosphere. Humans have pumped the fuel that you are part of out of the ground and have used it to power their airplanes. You are emitted as a waste.
4	Go to plants. Humans have pumped the fuel that you are part of out of the ground and have used it to create power at a power plant. You are emitted as dust from the stack pipe.
5	Go to atmosphere. Humans have pumped the fuel that you are part of out of the ground and have used it to power their tractor trailer truck. You are emitted as a waste from the tailpipe.
6	Go to atmosphere. Humans have pumped the fuel that you are part of out of the ground and have used it to power their SUVs. You are emitted as a waste from the tailpipe.



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