

## **DRK-12 Carbon Assessment, Form B**

Fall, 2013

Please don't include this first sheet in student copies.

This assessment is designed to elicit middle school or high school students' accounts of carbon-transforming processes.

Items 3, 5, 6, 12, and 15 were developed by AAAS Project 2061 and are available on their assessment website: <http://assessment.aaas.org/>.

This assessment was developed with support from the National Science Foundation, Grant number DRL 1020187: A Learning Progression-based System for Promoting Understanding of Carbon-transforming Processes. Prior development of some items was supported by grants from the National Science Foundation: Learning Progression on Carbon-Transforming Processes in Socio-Ecological Systems (NSF 0815993), and Targeted Partnership: Culturally relevant ecology, learning progressions and environmental literacy (NSF-0832173), and CCE: A Learning Progression-based System for Promoting Understanding of Carbon-transforming Processes (DRL 1020187). Additional support comes from the Great Lakes Bioenergy Research Center. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation or the United States Department of Energy.

Teacher: \_\_\_\_\_ Period: \_\_\_\_ Date: \_\_\_\_\_ Your Grade: \_\_\_\_ Your Initials: \_\_\_\_

## Form B—Introduction

This test will not affect your grade, but it is important. Your teacher is participating in a research project focusing on science learning. We are trying to learn how to teach science better. You can help us by answering these questions and explaining your ideas carefully.

### Practice Question

You will have several questions on this test that ask you to make two different choices about something. This is a practice question to help you understand how you should answer those questions. Try doing this practice question, then talk with your teacher if you have questions about it.

This question is about the 25 letters below:

A A A A A  
A B A A B  
A B A d A  
A B A A A  
A A A A E

Which of the following statements is true? Circle the letter of the correct answer.

- a. ALL of the letters are capital letters, OR
- b. SOME of the letters are lower case letters.

Circle the best choice to complete each of the statements about the capital letters.

How many of the capital letters are A's?	All or most	Some	None
How many of the capital letters are B's?	All or most	Some	None
How many of the capital letters are C's?	All or most	Some	None
How many of the capital letters are E's?	All or most	Some	None

### Correct answers

Did you answer the questions this way?

Which of the following statements is true? Circle the letter of the correct answer.

- a. ALL of the letters are capital letters, OR
- b. SOME of the letters are lower case letters.

Note that you have to choose either a or b.

Circle the best choice to complete each of the statements about the colored rectangle.

How many of the capital letters are A's?	All or most	Some	None
How many of the capital letters are B's?	All or most	Some	None
How many of the capital letters are C's?	All or most	Some	None
How many of the capital letters are E's?	All or most	Some	None

Note that you can make a different choice for each color

Teacher: \_\_\_\_\_ Period: \_\_\_\_ Date: \_\_\_\_\_ Your Grade: \_\_\_\_ Your Initials: \_\_\_\_

**Form B: 2013-2014**

1. Grass needs energy to live and grow. How does it get its energy?  
Which of the following statements is true? Circle the letter of the correct answer.

ALL of the grass's energy came originally from sources outside the plant, OR
SOME of the grass's energy was made by the plant as it grew.

Circle the best choice to complete each of the statements about possible sources of energy from outside the grass.

How much of the grass's energy come from AIR?	All or most	Some	None
How much of the grass's energy come from SUNLIGHT?	All or most	Some	None
How much of the grass's energy come from WATER?	All or most	Some	None
How much of the grass's energy come from SOIL NUTRIENTS?	All or most	Some	None

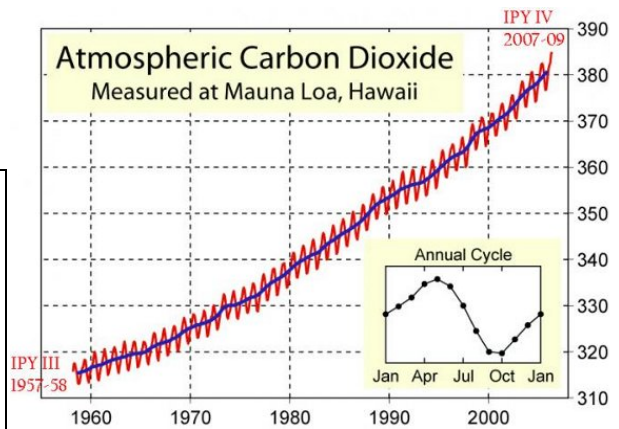
Explain your choices. How does the grass get its energy?

2. This graph shows changes in carbon dioxide in the atmosphere over a 47-year span in Hawaii. Other measurements in different places on the Earth show the same pattern.

a. Why do you think carbon dioxide levels go down in the summer and go up in the winter?

Circle the best choice to complete each of the statements. How much of the annual cycle is...

... caused by HUMANS BURNING COAL AND GASOLINE?	All or most	Some	None
... caused by CHANGES IN PLANT GROWTH?	All or most	Some	None
... caused by NUCLEAR POWER PLANTS?	All or most	Some	None
... caused by CHANGES IN WIND AND WEATHER?	All or most	Some	None



Explain your choices. Why does atmospheric carbon dioxide go down every summer and go up every winter?

Teacher: \_\_\_\_\_ Period: \_\_\_\_ Date: \_\_\_\_\_ Your Grade: \_\_\_\_ Your Initials: \_\_\_\_

b. Why do you think carbon dioxide in the atmosphere goes a little higher each year?  
Circle the best choice to complete each of the statements. How much of the continual rise is...

... caused by HUMANS BURNING COAL AND GASOLINE?	All or most	Some	None
... caused by CHANGES IN PLANT GROWTH?	All or most	Some	None
... caused by NUCLEAR POWER PLANTS?	All or most	Some	None
... caused by CHANGES IN WIND AND WEATHER?	All or most	Some	None

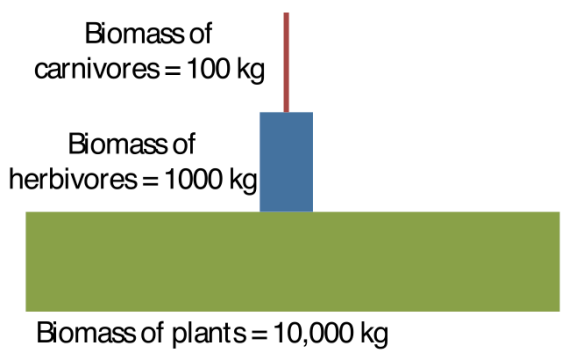
Explain your choices. Why is there a little more carbon dioxide in the atmosphere each year?

3. Milk contains water, carbohydrates, proteins, minerals, and fat. Is milk food for people?

- a. No, because liquids cannot be food, and milk is a liquid
  - b. No, because for something to be food it must provide both energy and building materials, and milk does not provide energy
  - c. Yes, because for something to be food it must provide energy, and the minerals in milk provide energy
  - d. Yes, because food is a source of energy and building materials, and milk provides energy and building materials



4. This graph shows a pattern that biologists have observed in most ecosystems on Earth. The biomass of plants is much more than the biomass of herbivores, and the biomass of herbivores is much more than the biomass of carnivores.



Why do you think that this is the case?

Teacher: \_\_\_\_\_ Period: \_\_\_\_ Date: \_\_\_\_\_ Your Grade: \_\_\_\_ Your Initials: \_\_\_\_



5. When a match burns, the ashes weigh less than the original match. What happened to the matter that used to be in the match?

Which of the following statements is true? Circle the letter of the correct answer.

- a. ALL of the matter is still somewhere in the environment, OR  
b. SOME of the matter was consumed by the flame and no longer exists.

Circle the best choice to answer each question about possible places where the matter in the match might go.

How much of the matter in the match goes into the AIR?	All or most	Some	None
How much of the matter in the match turns into HEAT AND LIGHT ENERGY?	All or most	Some	None
How much of the matter in the match goes into the SOIL?	All or most	Some	None
How much of the matter in the match goes into WATER VAPOR?	All or most	Some	None

Explain your choices. What happens to the matter in a match as it burns?

6. Gasoline is mostly a mixture of molecules such as octane:  $C_8H_{18}$ . Choose whether each of the following statements is true (T) or false (F) about what happens to the atoms in a molecule of octane when it burns inside a car.

- T F Some of the atoms in the octane are incorporated into carbon dioxide in the air.  
T F Some of the atoms in the octane are incorporated into air pollutants such as ozone ( $O_3$ ) or nitric oxide ( $NO_2$ ).  
T F Some of the atoms in the octane are converted into energy that moves the car.  
T F Some of the atoms in the octane are burned up and disappear.  
T F Some of the atoms in the octane are converted into heat.  
T F Some of the atoms in the octane are incorporated into water vapor in the atmosphere.

Explain the pattern in your answers. What happens to the atoms in the octane when it burns inside a car?

Teacher: \_\_\_\_\_ Period: \_\_\_\_ Date: \_\_\_\_\_ Your Grade: \_\_\_\_ Your Initials: \_\_\_\_

7. A scientist started sorting materials into two groups. Here are the first materials that she put into each group:

**Group A:** Gasoline, alcohol, wood

**Group B:** Sand, water, steel, carbon dioxide

a. Which group would you put these materials in?

Salt	Group A	Group B
Sugar	Group A	Group B
Pork	Group A	Group B
Soil minerals that help plants grow	Group A	Group B
Leaves of a living tree	Group A	Group B

b. Explain how you decided. How are the materials in Group A different from the materials in Group B?

c. Is there a different way of grouping the materials that makes more sense to you? YES NO

d. Explain your answer. How would you group the materials differently, or why do you like these groups?

8. Which of the following is food for a plant?

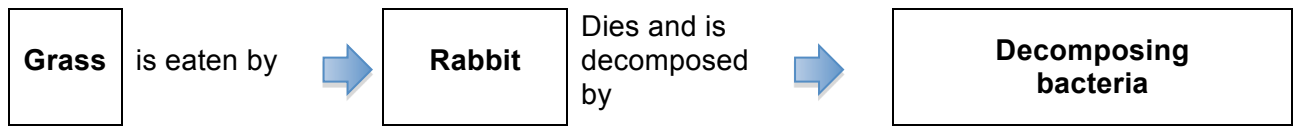
- a. Sugars that a plant makes
  - b. Minerals that a plant takes in from the soil
  - c. Water that a plant takes in through its roots
  - d. Carbon dioxide that a plant takes in through its leaves

9. Where does the food that a plant needs come from?

- a. The food comes in from the soil through the plant's roots.
  - b. The food comes in from the air through the plant's leaves.
  - c. The plant makes its food from carbon dioxide and water.
  - d. The plant makes its food from minerals and water.

Teacher: \_\_\_\_\_ Period: \_\_\_\_ Date: \_\_\_\_\_ Your Grade: \_\_\_\_ Your Initials: \_\_\_\_

10. Here is a simple food chain with one plant, one animal, and some decomposers:



Answer true or false to the following questions:

- True False The **molecules** in the rabbit came from the grass without changing.
- True False The **atoms** in the rabbit came from the grass without changing.
- True False The **energy** in the rabbit came from the grass without changing.
- True False The bacteria recycle **molecules** from the dead rabbit back to the grass.
- True False The bacteria recycle **atoms** from the dead rabbit back to the grass.
- True False The bacteria recycle **energy** from the dead rabbit back to the grass.

Explain your answers: How do **molecules** move through the ecosystem that this food chain is part of?

Explain your answers: How do **atoms** move through the ecosystem that this food chain is part of?

Explain your answers: How does **energy** move through the ecosystem that this food chain is part of?

11. As an animal grows, what happens to the food that it eats?

- a. All of the food is changed into waste that leaves the animal's body.
- b. All of the food is changed into energy in the animal's body and so the food is used up.
- c. Some of the food is changed into energy, and the rest leaves the animal's body as waste.
- d. Some of the food is changed into new substances that become part of the animal's body.

Teacher: \_\_\_\_\_ Period: \_\_\_\_ Date: \_\_\_\_\_ Your Grade: \_\_\_\_ Your Initials: \_\_\_\_

12. Do you think that turning on a light bulb causes carbon atoms to go into the atmosphere? YES NO

Where do the carbon atoms come from? Choose the best answer.

- a. Nowhere. Turning on a light bulb does not make carbon atoms move to the atmosphere.
- b. Combustion: The carbon atoms come from the heat and light energy of burning.
- c. Biomass: Recently living plants or animals.
- d. Soil carbon: Dead plants or animals in the soil.
- e. Fossil fuels: Petroleum, coal, or natural gas.

Explain your choice. What connection do you see between turning on a light bulb and CO<sub>2</sub> going into our atmosphere?

13. A burning candle is put into an air-tight container. After some time, the candle stops burning. Predict whether the air inside the jar will have more, the same, or less of the gases below.

<i>Gas</i>	<i>Prediction</i>		
<b>Oxygen:</b>	More	Same	Less
<b>Carbon dioxide:</b>	More	Same	Less
<b>Water vapor:</b>	More	Same	Less



Explain your predictions. How did the burning candle change the gases in the jar like you predicted?

What is happening to carbon atoms inside the jar?



Teacher: \_\_\_\_\_ Period: \_\_\_\_ Date: \_\_\_\_\_ Your Grade: \_\_\_\_ Your Initials: \_\_\_\_

14. When a match burns, there is heat and light energy in the flame. Where did that energy come from? Which of the following statements is true? Circle the letter of the correct answer.



- a. ALL of the energy came from the match or another source, OR
- b. SOME of the energy was created by the flame as it burned.

Circle the best choice to complete each of the statements about possible places where the energy in the flame might come from.

How much of the energy in the flame comes from the AIR?	All or most	Some	None
How much of the energy in the flame came from the PERSON WHO STRUCK THE MATCH?	All or most	Some	None
How much of the energy in the flame came from the WOOD OF THE MATCH?	All or most	Some	None
How much of the energy in the flame came from the WATER VAPOR?	All or most	Some	None

Explain your choices. Where does the heat and light energy in the flame come from?

After the flame goes out, does the energy still exist? YES NO

15. A patient is in the hospital. The nurse put a needle into his arm and connected it to a solution of sugar dissolved in water. Is the sugar and water solution that enters his body a source of food for the patient?

- a. Yes, because food is anything that provides energy, and the water in the solution provides energy
- b. Yes, because food is anything that is a source of both energy and building materials, and the sugar in the solution is a source of energy and building materials
- c. No, because liquids cannot be food, and the solution is a liquid
- d. No, because food has to enter the body through the mouth, and the sugar and water solution does not enter the patient's body through the mouth

