Bubbles in the Cabbage Juice

Skills: Science, Language Arts, Social Studies

Objective: Students will conduct experiments to discover carbon dioxide .

Background

Carbon dioxide gas is a colorless, odorless gas that is part of our atmosphere. It is formed by respiration (breathing), combustion (burning), chemical reaction and decomposition (rotting). Scientists think carbon dioxide is one of the gases that is causing the Earth's atmosphere to warm up.

Carbon is present in all organic matter. For thousands of years the carbon cycle on Earth was in balance. Plants took carbon gas from the air through photosynthesis and converted it to food, which animals could eat. Animals converted it back to carbon dioxide and released it back into the air through breathing or through waste materials which decomposed. Plants that died without being eaten released carbon dioxide back into the air as they decayed.

Millions of years ago, some of the plants and animals fell into wet, swampy places where there was little oxygen in the soil. Since the normal decay process is not possible without oxygen, these plants and animals released very small amounts of carbon as carbon dioxide and methane gas. Over time these masses of matter became oil, coal and natural gas which still contained most of the carbon from the original plants and animals. About 200 years ago, people discovered they could burn these materials to produce tremendous amounts of energy.

When people first started burning fossil fuels, they didn't realize they would be causing an imbalance in the carbon cycle. Once scientists discovered what was happening, they began to look for ways to solve the problem. One of the things they found was that during the 1980s an average 5.5 billion tons of carbon dioxide was released into the air through the burning of fossil fuels. During those same years, the amount of carbon dioxide in the air only increased by an average of 3.2 billion tons. By looking at those figures, scientists figured out that about 2.3 billion tons of carbon dioxide were taken up by plant photosynthesis. Scientists now are working on ways to use plants to take up even more of the extra carbon dioxide in our atmosphere. One simple way is to plant millions of trees.

Agricultural researchers are finding another possible solution in programs that were put in place for other reasons. Fifty years ago, the government established several programs designed to help stop the erosion of farm lands. Farmers were taught that their topsoil was not so likely to blow or wash away if they kept them covered with plants. Researchers have found that on land where these programs have been in place, large amounts of carbon from the atmosphere have been trapped in the soil and in the plants growing above them.

P.A.S.S.

GRADE 6

Science Process—1.1,2; 3.1,3,4,5,6; 4.1,3,4,5; 5.3,4
Physical Science—1.1; 2.1
Earth Science—5.1
Reading—1.1a; 3.1b,2a; 5.1ab,2a
Writing—2.4a,7
Social Studies—1.1,3

GRADE 7

Science Process—1.1,2; 3.1,3,4,5,6; 4.1,3,4,5; 5.3,4
Physical Science—1.1
Reading—1.1; 3.1a,2a; 5.1ab,2a
Writing—2.2ab,8
Social Studies—1.1; 2.2; 3.1; 5.2; 6.3

GRADE 8

Science Process—1.1,2; 3.1,3,4,5,6; 4.1,3,4,5; 5.3,4
Physical Science—1.1,2
Reading—1.1; 3.1ab,2ab; 5.1a,2a
Writing—2.2a,8
Social Studies—1.1,2,3

Resources Needed

1 purple cabbage

2 quarts distilled water

pitcher

clear, short, fat cups

funnel

measuring cups and spoons

yeast

sugar

1 bottle of club soda

baking soda

2 empty 16-ounce soda bottles

vinegar

balloons

soil samples from three different places with varying amounts of humus (organic content)

lab journal

Activities

Lead a discussion about global warming based on students' prior knowledge.

—Read and discuss background and vocabulary.

ACTIVITY 1

Advance Preparation

—Warn teachers in the surrounding classrooms that you will be conducting an experiment that smells bad.

—Bring distilled water to a boil.

—Chop the cabbage and add it to the boiling water.

—Remove the water from the heat and let it stand for about 30 minutes, stirring occasionally.

—Strain the liquid into a pitcher and let it cool.

—Label five clear short fat cups as follows:

control
yeast/sugar
baking soda/vinegar
club soda
breath

—Pour some of the cooled liquid into each of the cups.

—Set aside the remaining liquid to use in Activity 2.

Explain

—An indicator is a substance which indicates the presence, absence or concentration of a substance or the degree of reaction between two or more substances by means of a characteristic change, especially in color.

—Red cabbage contains a pigment molecule called flavin (an anthocyanin). This water-soluble pigment is also found in apple skin, plums, poppies, cornflowers, and grapes. Very acidic solutions will turn anthocyanin a red color. Neutral solutions result in a purplish color. Basic solutions appear in greenish-yellow. Therefore, it is possible to determine the pH of a solution based on the color it turns the anthocyanin pigments in red cabbage juice.

—Carbon dioxide makes carbonic acid when dissolved in water.

Procedure

—Remind students of potential hazards when mixing substances together. As always, practice safety procedures in all science activities.

—Divide students into four groups, and provide each group with one of the cards included with this lesson.

—Students will read the cards ahead of time to make sure they understand the procedure.

—Divide the cabbage juice evenly among the five labeled cups.

—Keep the "control" cup separate so all groups will be able to compare their results to it.

—Give each of the groups one of the labeled cups and the appropriate materials.

Summary

—After all groups have concluded their experiments, line up all four cups.

—Students will compare the four cups with the control cup and with each other.

—Students will summarize the investigation using the "Scientific Method Outline" included with this lesson.

—Students will answer the following questions in their summaries:

- Did one source of carbon dioxide cause more color change than the other sources?
- Which method would you use if you needed to make a large amount of carbon dioxide?
- How is carbon dioxide formed?

ACTIVITY 2

Explain

—Soils rich in humus (organic matter) tend to be more acidic than others.

—Decomposition and respiration of soil creatures makes carbon dioxide, which forms an acid when dissolved in water.

—Alkaline soils (less acidic) have low organic content. However, some soils will test high for acid even though they do not contain much organic matter.

Procedure

—Hand out the worksheet to each group of students.

—Students will follow the directions on the worksheet and write their results in their journal.

—Students will also copy and answer the questions from the worksheet into their journals.

Answers to Worksheet Questions

- If a soil tests acidic, does it have high or low organic content? (Usually high organic content, but not always. Sand may be acidic but contain low amounts of organic materials.)
- Why would the organic content of soil from a forest floor differ from that of a plowed field? (There generally is more organic matter in a forest than in a plowed field. A forest canopy will continually drop leaves, sticks, and other debris, whereas a plowed field has no canopy. However, some agricultural fields can be rich in added material, and some forests, such as those containing cedar trees, can be low in organic material.)
- Would all plants grow well in highly organic soil? (No. Desert plants grow best in low organic conditions.)

ADDITIONAL ACTIVITIES

1. Students will use online search engines or library references to research the history of carbonated beverages and learn how the bubbles in pop are formed.
2. Students will follow these directions to make their own carbonated bever-

Vocabulary

acidic—any compound that reacts with a base to form a salt

alkaline—any base, as soda or a mineral salt, which can neutralize an acid

carbon—a nonmetallic element that has the ability to form large numbers of organic compounds

carbon cycle—the exchange of carbon between living organisms and the environment. Carbon dioxide is taken from the atmosphere by photosynthesizing plants and returned by the respiration of plants and animals and by the combustion of fossil fuels.

carbon dioxide—a heavy colorless odorless atmospheric gas used during photosynthesis, in refrigeration, carbonated drinks, and fire extinguishers

decomposition—the breakdown of organic matter from a complex to a simpler form, mainly through the action of fungi and bacteria

greenhouse effect—warming of the Earth's surface as a result of atmospheric pollution by gases

humus—a dark-brown organic component of soil that is derived from decomposed plant and animal remains and animal excrement.

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ages.

—Combine 2 tablespoons citric acid and 1 tablespoon baking soda in a bowl.

—Use the back of a spoon to crush the mixture against the side of the bowl until it is a fine powder.

—Stir in 4 tablespoons powdered sugar.

—To make a fizzy drink, put 2 teaspoons of the mixture into a glass and add juice, water or some other non-carbonated beverage.

—Explain: The citric acid crystals dissolve and make citric acid. This reacts with the baking soda to make carbon dioxide gas. The gas bubbles move through the drink and makes it fizz. When the reaction is over, there is no more carbon dioxide, and the drink goes flat. The sugar takes away the sour taste of the citric acid and baking soda.

3. Students will use online search engines and/or library resources to research "greenhouse effect."

   —Students will create a time line, tracing the beginning knowledge of the problem, the building of the problem, government action to curb the problem, formation of action groups, and the results of the actions today.

Extra Reading

Asimov, Isaac. *How Did We Find Out About the Atmosphere?* Walker, 1985.

Burnie, David. *Plant – Eyewitness Books*, Dorling Kindersley, 2003.

The Concise Science Encyclopedia, Concise Encyclopedias, 2001.

Edom, Helen and Moira Butterfield. *Science with Air*, EDC, 1992.

Gifford, Clive. *The Kingfisher Geography Encyclopedia*, Kingfisher, 2003.

Johnson, Rebecca L. *The Greenhouse Effect: Life on a Warmer Planet*, Lerner, 1994.

Levine, Shar and Allison Grafton. *Projects for a Healthy Planet: Simple Environmental Experiments for Kids*, Jossey-Bass, 1992.

O'Neill, Mary Le Duc. *Air Scare*, Troll, 1990.

Vocabulary (Cont.)

organic—relating to, derived from, or characteristic of living things

oxygen—a colorless odorless gas that is the most abundant element, forms compounds with most others, is essential for plant and animal respiration, and is necessary in most cases for combustion

photosynthesis—a process by which green plants and other organisms turn carbon dioxide and water into carbohydrates and oxygen, using light energy trapped by chlorophyll

respiration—the chemical and physical process in which oxygen is delivered to tissues or cells in an organism and carbon dioxide and water are given off externally; the act of breathing air in and out.

Bubbles in the Cabbage Juice

GROUP 1: YEAST/SUGAR

Materials:
- jar with cabbage juice
- funnel
- 16-ounce soda bottle
- balloon
- 1 packet of yeast
- 1 teaspoon sugar
- 1/2 cup warm water

1. Blow up a balloon and let the air out.
2. Use the funnel to put the yeast, sugar and warm water into the soda bottle, and let it sit for about 10 minutes.
3. Put a balloon over the mouth of the bottle and gently shake the contents.
4. Let the bottle and balloon sit until the balloon is inflated.
5. Twist the balloon closed.
6. Release some of the gas from the balloon into the cabbage juice jar.
7. In a journal, record materials used, steps completed, and results.
8. Compare with the "control" cup to justify your results.

GROUP 2: BAKING SODA/VINEGAR

Materials:
- jar with cabbage juice
- funnel
- 16-ounce soda bottle
- balloon
- 1 tablespoon baking soda
- 2 tablespoons vinegar

1. Blow up a balloon and let the air out.
2. Use a funnel to place baking soda in the bottle.
3. Use a funnel to place vinegar in the balloon.
4. Attach the balloon to the mouth of the bottle, and allow the vinegar to flow into the bottle to mix with the baking soda.
5. When the balloon inflates, twist the opening, and remove it from the bottle.
6. Release some of the gas from the balloon into cabbage juice in the cup.
7. In a journal, record materials used, steps completed, and results.
8. Compare with the "control" cup to justify your results.

GROUP 3: CLUB SODA

Materials:
- jar with cabbage juice
- bottle of club soda
- balloon

1. Blow up a balloon and let the air out.
2. Open the bottle of club soda, and quickly put the balloon on the bottle mouth.
3. Let the balloon stay on the bottle until it inflates.
4. Twist the balloon closed.
5. Take the balloon off the bottle.
6. Release some of the gas from the balloon into the cup of cabbage juice in the cup.
7. In a journal, record materials used, steps completed, and results.
8. Compare with the "control" cup to justify your results.

GROUP 4: BREATH

Materials:
- jar with cabbage juice
- balloon

1. Blow up a balloon, and let the air out.
2. Blow up the balloon again and twist the opening.
3. Release some of the gas from the balloon into the cup of cabbage juice in the cup.
4. In a journal, record materials used, steps completed, and results.
5. Compare with the "control" cup to justify your results.

Produced by Oklahoma Ag in the Classroom, a program of the Oklahoma Cooperative Extension Service, the Oklahoma Department of Agriculture, Food and Forestry and the Oklahoma State Department of Education, 2008.

Name _____

Activity 2 Worksheet

MATERIALS PER TEAM

1 12-oz cup of cabbage juice
5 baby food-sized jars
¼ cup vinegar
6 teaspoons baking soda
3 soil samples from 3 different locations
log or journal

INSTRUCTIONS

1. Place a different soil sample in each of the three jars. Fill each about one-fourth full with soil.
2. Fill each jar halfway with cabbage water.
3. The redder the water gets, the more acid the soil is. This usually means the soil is high in organic content.
4. The more blue the water, the more alkaline the soil. This usually means the soil is low is organic content.
5. Fill the two remaining jars halfway with cabbage water.
6. Add ¼ cup of vinegar to one. The liquid should turn red indicating extreme acid conditions.
7. Add 6 teaspoons baking soda to the other jar. The liquid should turn blue indicating extreme alkaline conditions.
8. Use these last two jars to compare the acidity and alkalinity of the 3 soil jars.
9. Line up the jars from blue to purple to red.
10. Record your procedures and results from this investigation in a lab book or journal.
11. Copy the questions from the worksheet and answer them in the journal.

QUESTIONS

- If a soil tests acidic, does it have high or low organic content?

- Which would have more organic content—soil from a forest floor or soil from a plowed field?

- Would all plants grow well in highly organic soil?

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Name_____

Scientific Method Format

Title of Experiment or Study:

I. Stating the Problem:
   What do you want to learn or find out?

II. Forming the Hypothesis:
   What is known about the subject or problem, and what is a prediction for what will happen?

III. Experimenting: (Set up procedures)
   This should include: materials used; dates of the experimental study; variables, both dependent and independent (constant and experimental); how and what was done to set up the experiment; fair testing procedures.

IV. Observations:
   Includes the records, graphs, data collected during the study.

V. Interpreting the Data:
   Does the data support/defend the hypothesis?

VI. Drawing Conclusions:
   Justify the data collected with concluding statements about what has been learned. Discuss any problems or concerns. Use other studies to support the conclusion. Give alternative ideas for testing the hypothesis.

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