Activity 7: Why Should I Care?

What You Will Do: Show how increased carbon dioxide makes the ocean more acidic

Big Idea

Climate change will have consequences for the Earth system and human lives.

(Climate Science Principle 7)

What You Will Need

- Adult partner
- 5 – Clear glass jars or plastic cups, about 250 ml (8 oz) capacity
- 1 – Graduated cylinder or measuring cup, about 250 ml (8 oz) capacity
- 1 – Measuring spoon, about 1 ml (1/4 tsp) capacity
- 1 – Measuring spoon, about 5 ml (1 tsp) capacity
- 1 – Small pot, about 1 liter (1 qt) capacity
- 1 – Funnel, about 7 cm (3 in) diameter
- Safety glasses
- Cheesecloth, about 30 cm (12 in) square
- 500 ml (2 c) finely chopped red cabbage
- Drinking straw
- Boiling water, about 500 ml (2 c)
- Baking soda
- White vinegar

Increased carbon dioxide in the atmosphere is leading to many changes that have serious consequences for Earth's ecosystems, including humans. Climate change is causing ice sheets and glaciers to melt, and sea level rises as the melt water flows into Earth's ocean. Seawater is beginning to contaminate sources of fresh water. Rising sea level is submerging coastal marshes that help protect the shore from severe storms, and bringing structures on land closer to the edge of the ocean. These changes make it more likely that these structures will be damaged by coastal storms, which are expected to increase as additional heat in Earth's atmosphere changes the patterns of winds and precipitation. Heat waves and droughts are also expected to increase, and bring additional threats to human lives.

Limacina helicina, a free-swimming planktonic snail. These snails, known as pteropods, form a calcium carbonate shell and are an important food source in many marine food webs. As levels of dissolved CO_2 in sea water rise, skeletal growth rates of pteropods and other calcium-secreting organisms will be reduced due to the effects of dissolved CO_2 on ocean acidity. Image credit: Russ Hopcroft, UAF/NOAA.

In addition to other impacts of global climate change, ocean acidification poses potentially serious threats to the health of Earth's ocean and its ecosystems. The impact on individual species is expected to vary. A more acidic environment has a dramatic effect on some species that build calcium carbonate (limestone) shells, such as oysters. When shelled organisms are at risk, the entire food web also is at risk. For example, pteropods are an important food source for salmon. According to some research reports, a 10 percent drop in pteropod production could result in a 20 percent drop in the mature body weight of pink salmon (*Oncorhynchus gorbuscha*). These impacts are happening right now, and are affecting marine food webs that provide important sources of food for humans as well as ocean species.

Increased atmospheric carbon dioxide is also causing serious changes in the chemistry of Earth's ocean. The ocean absorbs about a quarter of the carbon dioxide humans release into the atmosphere every year, and this additional carbon dioxide in seawater is causing Earth's ocean to become more acidic. Scientists use a measurement called pH to describe how acidic or basic a solution is. A pH of 7 is considered neutral. Acidic solutions, such as vinegar or lemon juice, have a pH less than 7. The more acidic a solution is, the lower the pH number. Basic solutions, such as milk or baking soda dissolved in water, have a pH greater than 7.

How It Works

Red cabbage contains chemicals that change color depending upon pH. These types of chemicals are called pH indicators. In basic solutions, these chemicals from red cabbage are light blue, but they change to pink-purple in acidic solutions. At the beginning of your demonstration, you will put a very small amount of baking soda into the container of tap water to be sure that it is slightly basic (seawater is normally slightly basic, with a pH of about 8.2). So, when you add the red cabbage indicator solution to the container of tap water, the indicator will have a light blue color.

When you exhale, the air from your lungs contains more carbon dioxide than the air in the atmosphere. Blowing through a straw into the container of tap water bubbles carbon dioxide through the liquid. Some of this carbon dioxide dissolves to form a weak acid (carbonic acid). When this happens, the red cabbage indicator changes to a pink-purple color, showing that the pH has changed and the liquid has become more acidic.

How to Do It

1. Put the chopped red cabbage into a small pot, and pour in about 500 ml (2 c) boiling water to cover the cabbage. Let the mixture rest for about 30 minutes.

2. Fold the cheesecloth so that it is at least four layers thick, but still covers the opening of the funnel. Strain the cabbage mixture through the cheesecloth into one of the glass jars or plastic cups. You will have some liquid left over in the pot. Save this in case you need it later.

3. Pour about 50 ml (1/4 c) of tap water into another glass jar or plastic cup. Add 5 ml (1 tsp) of the red cabbage indicator solution to the jar. The solution should have a pale blue color. The pH of tap water varies from place to place, so if the solution is not pale blue, add a pinch of baking soda, and gently swirl the container so that the baking soda dissolves. Repeat if necessary until the solution has a pale blue color.

4. Pour about 50 ml (1/4 c) of tap water into another glass jar or plastic cup. Add 5 ml (1 tsp) of the red cabbage solution to the jar, then add 5 ml (1 tsp) of white vinegar. The solution should have a pink-purple color.

5. Put about 1 ml (1/4 tsp) of baking soda into another glass jar or plastic cup, fill the container with tap water, and gently swirl the container so that the baking soda dissolves.

6. Pour about 50 ml (1/4 c) of tap water into the last glass jar or plastic cup. Add 1 ml (1/4 tsp) of the baking soda solution from Step 5 solution to the jar, then add 5 ml (1 tsp) of the red cabbage solution to the jar. The solution should have a pale blue color.

7. Put on a pair of safety glasses. Blow gently through the straw into the solution prepared in Step 6. Keep blowing for several minutes, until the color of the solution changes from pale blue to pink-purple. You have just shown how dissolved carbon dioxide can make a solution more acidic!

This is what is happening to Earth's ocean because of carbon dioxide that has been added to Earth's atmosphere by human activities.

Want To Do More?

This Web page has more information about ocean acidification: **http://www.pmel.noaa.gov/co2/story/What+is+Ocean+Acidification%3F**. Images on this page show what happens to a pteropod (pronounced "TARE-oh-pod") shell when it is exposed to seawater with a pH that is lower than normal. After 45 days, the shell slowly dissolves. Earth's ocean is not this acidic yet, but is predicted become this acidic by the year 2100 if humans continue the present pattern of adding carbon dioxide to the atmosphere.

For more information about ocean acidification, check out these slide shows and videos: *http://coralreef.noaa.gov/education/oa/presentation-videos.html*

Left: Red cabbage solution;
Right: Blue cabbage solution