ACIDIC OCEAN

This lesson plan developed by:

Overview:

Ocean acidification is sometimes called climate change's equally evil twin and it's caused by the same problem: excess carbon dioxide getting released into the atmosphere due to the burning of fossil fuels. Our oceans absorb about 25% of the carbon dioxide that is released into the atmosphere. When that excess carbon dioxide dissolves into the ocean, it can change the chemistry of the water, causing the oceans to become more acidic. Scientists use a measurement called pH to determine how acidic or basic solutions are. This fun activity uses a natural pH indicator from red cabbage and your own exhaled breath the visualize how our oceans are becoming more acidic due to increasing carbon dioxide emissions.

Materials:

- 4 glass jars or cups, about 8oz capacity
- Large glass container
- Measuring cups
- Measuring spoons
- Small pot
- Strainer
- Drinking straws (not made of plastic, if possible)
- 2 cups of chopped red cabbage
- Baking soda
- White vinegar
- Tap water

Materials:

The red cabbage pH indicator can be made ahead of time and stored in the refrigerator until the activity. However, students may want to help make the solution.

1. In the small pot, boil about 2 cups of water. Take the pot off the heat.
2. Place the chopped red cabbage into the boiling water. Mix and then cover the pot. Let the mixture sit for about 30 minutes.
2. Place the large glass container under the strainer to collect the cabbage liquid. Pour the mixture through the strainer. Dispose of the red cabbage and save the liquid (natural pH indicator).

Duration:
30 minutes (if red cabbage pH indicator is prepared ahead of time)

Physical Activity:
Moderate

Background:
Increased carbon dioxide in the atmosphere is leading to many changes that have significant consequences for Earth's ecosystems. Climate change is causing ice sheets and glaciers to melt, sea level rise, and changes in weather patterns, including drought and flooding. The increase in carbon dioxide emissions is also causing serious changes in the chemistry of our ocean.

The ocean absorbs about a quarter of the carbon dioxide humans release into the atmosphere every year. When carbon dioxide is absorbed by seawater, a series of chemical reactions occur resulting in the increased concentration of hydrogen ions. This increase causes the marine water to become more acidic and causes carbonate ions to be relatively less abundant. Carbonate ions are an important building block of structures such as sea shells and coral skeletons. A decrease in carbonate ions can make building and maintaining shells and other calcium carbonate structures difficult for calcifying organisms, including oysters, clams and urchins. Ocean acidification can also affect the behavior of non-calcifying organisms as well. For example, some fish's ability to detect predators decreases in more acidic waters.

Scientists use a measurement called pH to determine 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. Seawater is normally slightly basic. Prior to the Industrial Revolution, the average ocean pH was about 8.2. Today the average ocean pH is about 8.1 (becoming more acidic).

Red cabbage contains natural chemicals that change color depending upon the pH. These types of chemicals are called pH indicators. In basic solutions, these chemicals from red cabbage are blue, but they change to pink-purple in acidic solutions. 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.

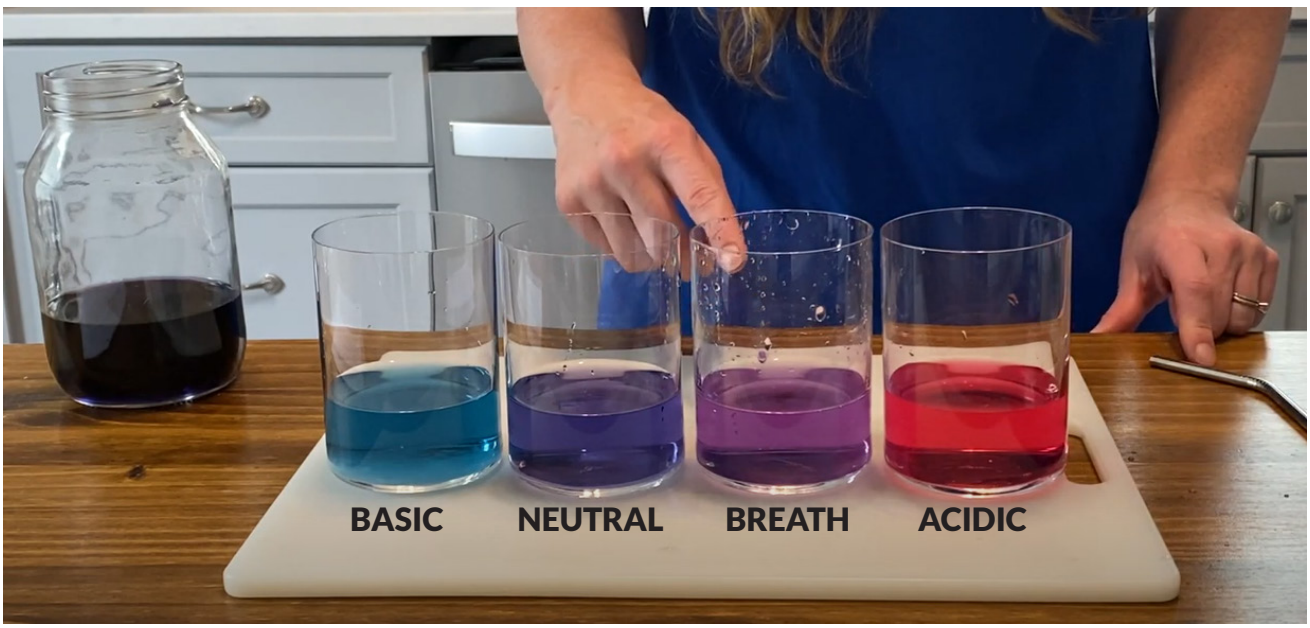
Activity:

Part 1: Introduction to Ocean Acidification

1. Ask the whole group the following questions:
   - What is ocean acidification?
   - What causes ocean acidification?
2. Discuss what some of the impacts of ocean acidification may be on ocean animals.
3. Discuss the scientific measurement, pH. What does it measure?

Part 2: Test the pH of Different Liquids

1. Pour 1/4 cup of tap water into each of the four glass jars. Add one tablespoon of red cabbage indicator into each glass jar. The solution should have a pale blue-purple color. The pH of tap water varies from place to place.
2. One jar will be your control to compare to the other jars. In the second jar, add a pinch of baking soda, and gently swirl the container so that the baking soda dissolves. Repeat if necessary until the solution is pale blue color. This is your basic solution. Seawater is normally slightly basic with a pH of about 8.2.
3. In the third jar, add 1 teaspoon of white vinegar and gently swirl. This solution should have a pink color. This is your acidic solution.
4. In the fourth jar, blow gently into the liquid for several minutes. Observe what happens to the liquid.



Acidic Ocean (cont.)

Discussion:

You have just shown how dissolved carbon dioxide can make a solution more acidic. This is what is happening to our ocean because of carbon dioxide that has been added to Earth's atmosphere by human activities.

- What are some human activities that contribute to ocean acidification?
- What would happen if shellfish were no longer able to make their shell or coral reefs weren't able to grow?
- What are some ways humans can reduce carbon emissions?

Additional Resources:

To learn more about the activity, check out our Acidic Ocean "how to" video.

Ocean Literacy Principles:

Ocean literacy is an understanding of the ocean's influence on us, and our impact on the ocean. There are seven Ocean Literacy Essential Principles that all people of our blue planet should have an opportunity to learn and understand. This activity touches upon the following Essential Principles:

1. The Earth has one big ocean with many features
3. The ocean is a major influence on weather and climate
5. The ocean supports a great diversity of life and ecosystems
6. The ocean and humans are inextricably interconnected
7. The ocean is largely unexplored

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