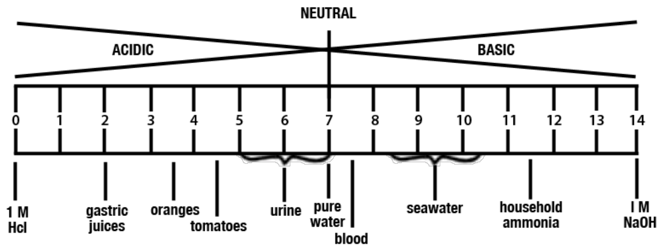
OCEAN ACIDIFICATION

Part 1: What Happens to pH?

Introduction

pH (potential of Hydrogen) is the measure of the acidity or alkalinity (basicity) of a substance. It is measured on a scale of 1.0 to 14.0. A pH of 1-6 indicates that a substance is acidic, with the lower values indicating a higher acidity. Vinegar and lemon juice are examples of substances that have an acidic pH. A pH of 7 indicates that a solution is neutral. Water is an example of a substance that has a neutral pH. A pH of 8-14 indicates that a substance is basic (or alkaline), with higher numbers indications a higher alkalinity. Bleach and ammonia are two examples of substances with a basic pH. Figure 1 below shows the pH scale.

Figure 1: pH Scale



Source: http:www.epa.gov/volunteer/stream/vms54.html

On the scale above, seawater is shown to be slightly basic, with a pH ranging from approximately 8.5 to 10. In the following experiment, you will discover what happens to pH when carbon dioxide mixes with seawater. Marine life needs a certain pH range in order to survive.

Ocean acidification refers to the decrease in pH caused by the uptake of CO2 from the atmosphere. Oceans absorb carbon dioxide, and as more CO2 dissolves in the oceans, the pH decreases, changing the chemistry of the water. As ocean waters become more acidic, marine life may die. Corals are very sensitive to changes in pH, and when they die, become white, a phenomenon known as "coral bleaching." In this activity, you will explore pH changes in a variety of liquids.

Activity

Materials:

- 4 test tubes
- Test tube rack
- pH indicator strips
- 1 dropper container of pH indicator
- 4 500 mL beakers
- 250 mL of distilled water
- 250 mL of artificial seawater
- 250 mL of carbonated water
- 250 mL of tap water
- 4 straws
- Marking pen
- Student Worksheets

Procedure:

1. Read the introduction and article provided by your teacher.
2. Gather materials for your group.
3. With your group, develop a hypothesis. Predict what will happen to the pH of each of the four types of water when carbon dioxide is added. Write your hypothesis on your student worksheet.
4. Label your control test tubes with the four types of water: distilled water, seawater, tap water, and carbonated water. Fill them and place them back in the rack. These are your control samples.
5. Label your sample cups with the four types of water. Fill them each with 250 mL of fluid. These are your experimental samples.

6. Add 2-4 drops of pH indicator to the fluids in each test tube. Add 10 drops to the fluids in each cup. Be sure to add the same amount to each group.

7. Under "Control Color" write the colors of your control samples. Check that the control colors match the experimental sample colors. Hold the tubes or cups in front of white paper if you need help telling the colors apart.

8. Use the color scale on your Student Worksheet to estimate the pH of your experimental fluids. Record under "Start pH."

9. With a pH strip, measure the pH of each liquid. Record under "Start pH (pH paper)."

10. Place a straw in each cup. Without sucking up any water into your mouth, blow through the straw into the distilled water sample so that bubbles come up through the water.

11. Keep blowing for 45 seconds and move the bottom of the straw around to make sure bubbles flow through all the liquid. (Note: you may take quick breaths in between, but remove your mouth from the straw to avoid sucking up liquid.)

12. At the end of 45 seconds of bubbling, write down the color of the water under "End Color."

13. Use the color scale on your Student Worksheet to estimate the pH the distilled water after bubbling. Record under "End pH" on your data chart.

14. Use a pH test strip to measure the end pH of your samples. Record in the column labeled "End pH (pH paper)."

15. Repeat steps 10-14 for each liquid.

16. Answer the questions on your Student Worksheet.

[3] Adapted from Cooley (2009)

Part 2: Coral Degradation

Introduction

Coral reefs are extremely diverse marine ecosystems being host to over 4,000 species of fish, massive numbers of jellyfish, mollusks (shellfish), crustaceans (crabs, lobsters), and many other animals. Reefs are made up of calcium carbonate secreted by corals, a marine organism. Corals are highly sensitive to environmental changes, including temperature and pH. The corals that form the structure of the great reef ecosystems of tropical seas depend on a symbiotic relationship with photosynthesizing algae called zooxanthellae. These algae live within the coral tissues and give coral its coloration. Under stress from environmental changes, corals expel their zooxanthellae, which leads to a lighter or completely white appearance, hence the term “coral bleaching.” Scientists have predicted that over 50% of the world’s coral reefs may be destroyed by the year 2030 due to changes in the ocean environment.

In addition to causing coral bleaching, changes in pH can deteriorate calcium carbonate: the building block of coral reefs as well as the makeup of the shells and skeletons of mollusks. Higher rates of bleaching and calcium carbonate damage have been linked to climate change, and once degradation occurs, it can continue to devastate the ecosystem.

The marine food chain depends on coral reefs. Humans eat a variety of seafood that come from, or develop in, coral reefs. A disruption in the coral reef ecosystem will effect the food chain which, in turn can impact human health. A change in the pH of the oceans can affect the food chains and human health, including the increased presence of neurotoxins (chemicals that affect the brain) in fish, as well as a decreased supply of food, which can lead to malnutrition in people who depend on seafood. In this activity, you will explore how a change in ocean pH affects shells, which are composed of calcium carbonate.

Activity

Materials:

- White vinegar-water solution
- Scale
- Gloves
- pH indicator paper
- Forceps
- 2 Glass beakers
- Small, thin seashells (1-2 inches in diameter), 2 for each group
- Water
- 2 500 mL Beaker

Procedure[4]:

1. Collect all materials for your group.
2. Fill one beaker with the vinegar/water solution. Label container as “experiment.”
3. Fill the second beaker with an equal amount of water. Label as “control”.
4. Record the pH values for both beakers.
5. Measure the weight of each shell with a scale. Record this value on your data sheet.
6. Place one shell in each of the beakers.
7. Observe the shells at the beginning and end of each class period. What is happening in each of the beakers?
8. When the shells placed in the vinegar solution are visibly degraded (1-2 class periods), use the forceps to remove the shells and rinse them off with clean water. (Note: wear gloves when performing this step).
9. Make observations about the control shell and the experimental shell. Record your observations on your data sheet.
10. Measure the weight of the shells. Record on your data sheet.
11. Calculate the percent of mass lost in the shells by using the formula on your worksheet.
12. Answer the questions on your student worksheet.

[4] Adapted from Boleman, Casey., Gravinese, Philip., and Muse, Ellen. Dude, where’d the reef go? Florida Tech Integrated Science Teaching Enhancement Partnership.

Name: ________________________________

Part 1 Student Worksheet: What Happens to pH?

Instructions: Fill in your hypothesis and the chart below as your conduct your experiment.

Hypothesis:

Table 1: Changes in pH

Liquid	Control Color	Start pH (color)	Start pH (pH paper)	End Color	End pH (color)	End pH (pH paper)
Distilled Water						
Seawater						
Tap water						
Carbonated Water						

Cabbage Juice pH Indicator Scale

acid neutral base

(http://www.greatscience.com/images/user/projectImages/pH.jpg)

Discussion Questions: What Happens to pH?

Instructions: Based the reading and your experiment, answer the following questions.

1. Which sample had the highest pH before bubbling? The lowest before bubbling?

2. Did the measuring with pH paper give you approximately the same results as measuring pH with the color change?

3. Your breath contains carbon dioxide. After bubbling the samples with your breath, describe what happened in the samples compared to your controls.

4. Which sample had the highest pH after bubbling? Which had the lowest pH after bubbling?

5. What happened to the pH of the seawater after bubbling?

6. CO2 is released during the burning of fossil fuels. As humans use more fossil fuels, more CO2 is released into the atmosphere. Oceans naturally absorb CO2. What do you think will happen to the pH of oceans if CO2 continues to be released into the atmosphere?

Name: ________________________________

Part 2 Student Worksheet: Coral Degradation

Instructions: Write your hypothesis and record your observations in the spaces provided. Fill in the chart below as your conduct your experiment. Record your observations throughout the experiment in the space provided. Calculate percent mass lost with the formula provided. Show your work in the space provided and record your final answer in the table.

Hypothesis:

Observations:

Table 1: Coral Mass

	pH	Beginning weight (g)	End weight (g)	Percent Mass Lost
Control				
Experimental				

To calculate Percent Mass Lost:

$$\text{Percent mass lost} = \frac{(\text{initial mass} - \text{final mass}) \times 100}{(\text{initial mass})}$$

Discussion Questions: Coral Degradation

Instructions: Based on the reading and your experiment, answer the following questions.

1. What happened to the shell placed in vinegar-water? How much mass did the shells lose?

2. What would you expect to happen if the pH of the vinegar-water was lower?

3. What happens to coral reefs if ocean pH changes?

4. How do coral reefs benefit humans? How would a loss of coral reefs impact humans?

5. List two ways in which excessive CO2 can lead to the ocean's decline.

6. What are some ways to reduce coral degradation and death?

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RESOURCES:

Environmental Health Perspectives, News by Topic page, (**http://www.ehponline.org/article/browsenews.action**). Choose Climate Change/Global Warming, Marine Science

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