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Urgent Lessons: Measuring the Effects of Climate Change

Experiment

Acidification of Water by CO_2

- Go Direct pH Sensor

Workshop Presenter

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Acidification of Water by CO_2

As carbon dioxide gas, CO_2, dissolves in water, the following reaction occurs:

$$CO_2 + H_2O \leftrightarrow H_2CO_3$$

Carbonic acid, H_2CO_3, is a weak acid that as it increases in concentration, can lower the pH of natural bodies of water. As water becomes more acidic this results in damage to phytoplankton, zooplankton, coral, and any organism that has calcium carbonate as part of it's body.

The acidity of a solution can be expressed using the pH scale, which ranges from 0 to 14. Solutions with a pH above 7 are basic, solutions with pH below 7 are acidic, and a neutral solution has a pH of 7. In this experiment, you will study how the pH of water changes when CO_2 is dissolved in water.

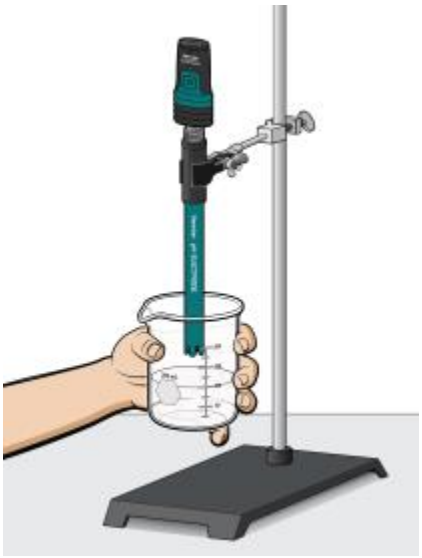

Figure 1

OBJECTIVES

- Use a pH Sensor to measure changes in pH.
- Study the effect of dissolved CO_2 on the pH of water.
- Learn why some bodies of water are more vulnerable to acidification than others.

MATERIALS

Chromebook, computer, **or** mobile device
Graphical Analysis app
Go Direct pH
250 mL beaker
100 mL beaker (rinse beaker)
125 mL Erlenmeyer flask
10 mL graduated cylinder
stopper with tubing
buffer solution
2 Alka-Seltzer® tablets
water
ring stand
utility clamp
wash bottle with distilled water
waste container
water samples from natural bodies of water (lake, stream, ocean)
goggles

PROCEDURE

1. Obtain and wear goggles.
2. Before each use of the pH Sensor, you need to rinse the tip of the sensor thoroughly with distilled water. To do this, hold the pH Sensor above a rinse beaker and use the wash bottle to thoroughly rinse the sensor tip. **Important**: Do not let the pH Sensor dry out. Keep it in a 250 mL beaker with about 100 mL of tap water when not in use. The tip of the sensor is made of glass—it is fragile. Handle with care!
3. Launch Graphical Analysis. Connect the pH Sensor to your Chromebook, computer, or mobile device.
4. Place one Alka-Seltzer tablet in the Erlenmeyer flask.
5. Put 100 mL of fresh water into a clean 250 mL beaker.
6. Using a ring-stand and utility clamp, secure the pH Sensor in the beaker. The tip of the sensor should be down in the water sample. Swirl the water around the sensor tip briefly. **Note**: All glassware must be clean in this experiment!
7. Once the pH reading stabilizes, click or tap Collect to start data collection.
8. Quickly place 10 mL of water in the Erlenmeyer flask then seal with the stopper. Place the tubing in the water sample so it starts to bubble the water with the gas being released from the reaction.
9. When data collection is finished, click or tap on Graph Tools, , and choose Statistics to determine the maximum and minimum pH values. Record the maximum and minimum pH in Table 1.
10. Repeat Steps 4–9 using a different water sample form a natural source in place of fresh water. **Note**: The previous data set is automatically saved.

11. Tap on the y-axis and select all data sets to view all four on the same plot. Use this graph to answer the discussion questions at the end of this experiment.

DATA

Table 1			
Water Type	Maximum pH	Minimum pH	ΔpH

DISCUSSION QUESTIONS

1. Calculate the change in pH (ΔpH) for each water sample. Subtract the final pH from the initial pH. What conclusion can you make about your breath?

2. Why does the pH change rapidly at first, and remain stable after a time?

3. Compare the ΔpH values. Which test gave the largest pH change? Which test gave the smallest pH change?

4. Water from the ocean is said to be "naturally buffered." From the result of this experiment, what does this mean?

5. How does water from the ocean become buffered?

6. Many aquatic life forms can only survive in water with a narrow range of pH values. In which body of water—lakes or oceans—would living things be more threatened by acidification? Explain.

7. Summarize your conclusions about this laboratory experiment. Use your data to answer the purposes of this experiment.

EXTENSIONS

1. Test hard and soft water in the same way you tested lake and ocean water. How do they compare?

2. Do research to get more information on the effects of acidification on ocean and freshwater.

3. Do research and prepare a report on "naturally buffered" streams and lakes.