Acid Rain Lab

Acid rain is a topic of much concern in today's world. As carbon dioxide gas, CO_2, dissolves in water droplets of unpolluted air, the following reaction occurs:

$$CO_2 + H_2O \leftrightarrow H_2CO_3$$

H_2CO_3 is a weak acid that causes the rain from unpolluted air to be slightly acidic. This source of "acid rain" is not usually considered to be a pollutant, since it is natural and usually does not alter the pH of rainwater very much. Oxides of sulfur dissolve in water droplets to cause more serious problems. Sulfur dioxide dissolves to produce sulfurous acid, H_2SO_3, by the equation:

$$SO_2 + H_2O \leftrightarrow H_2SO_3$$

This source of sulfur dioxide can occur naturally, as from volcanic gases. More often, however, sulfur dioxide is considered a pollutant, since it is a by-product of fossil fuel combustion.

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 Part I of this experiment, you will study how the pH of water changes when CO_2 is dissolved in water. In Part II, you will study the effect sulfuric acid has on the pH of different water types.

OBJECTIVES

- Study the effect of dissolved CO_2 on the pH of distilled water.
- Study the effect on pH of dissolving H_2SO_4 in various waters.
- Learn why some bodies of water are more vulnerable to acid rain than others.

MATERIALS

Labquest
250 mL and 100 mL beaker
buffer solution
dilute H_2SO_4
ring stand and utility clamp
straw
washbottle with distilled water
water from a lake
water from the ocean

PROCEDURE

Part I CO_2 and Water

As carbon dioxide gas, CO_2, dissolves into water droplets suspended in the atmosphere, it changes the rainwater's pH. Here you will test to see if CO_2 will affect the pH of distilled water. The source of CO_2 will be your breath.

1. Obtain and wear goggles.
2. Connect the pH Sensor to the Labquest. "Old" type sensors will need to be designated. Go to "sensors", "set-up", choose the correct channel and select "pH", "OK".
3. Use a rinse bottle to thoroughly rinse the pH electrode as shown by your teacher. Catch the rinse water in the 250 mL beaker.
4. Wash a 100 mL beaker with tap water and dry it with a paper towel. Note: All glassware must be clean in this experiment! Put 50 mL of **boiled** distilled water into this clean beaker. Lower the pH electrode into the distilled water and swirl the water around the electrode briefly.

5. Record the initial pH in your lab notebook (see table 1...maximum pH). Then use a straw to blow your breath into the distilled water for 1 minute. Your breath contains CO_2.
6. After 1 minute of blowing, record the minimum pH in your lab notebook.

Part II Simulating Acid Rain Using H_2SO_4

7. Rinse the pH electrode thoroughly with distilled water.
8. Wash and dry the 100 mL beaker. Get a new 50 mL portion of **non-boiled** distilled water. Place the pH electrode into the distilled water and secure in place with a ring stand and utility clamp.
9. Record the initial pH in your lab notebook (see table 2).
10. Add 1 drop of H_2SO_4 (sulfuric acid) to the water. Stir thoroughly, until the pH is stable. Record. **CATUTION:** *Handle the sulfuric acid with care. It can cause painful burns if it comes into contact with skin.*
11. Repeat step 10, adding 1 drop at a time, until you have added 10 drops of acid.

H_2SO_4 and water from the Ocean

12. Complete these steps:
    a. Clean the pH electrode.
    b. Wash and dry the 100 mL beaker.
    c. Get a 50 mL portion of "Ocean Water" in the 100 mL beaker, lower the pH electrode into this water, and then briefly swirl the water about the electrode.
    d. Repeat Steps 10-11 for this sample.

H_2SO_4 and Lake Water

13. Repeat step 12 using "Lake Water" from your teacher.

H_2SO_4 and Buffer Solution

14. Repeat step 12 using "Buffer Solution" from your teacher.

PROCESSING THE DATA

Part I

Table 1 Adding CO_2 from your breath to water		
Maximum pH	Minimum pH	△pH

Part II

Table 2				
Drops	pH of this water type			
	Distilled	Ocean	Lake	Buffer
0				
1				

2				
3				
4				
5				
6				
7				
8				
9				
10				
△pH				

QUESTIONS

1. Calculate the change in pH (△pH) for the water in Part I. 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. Calculate the change in pH (△pH) for each of the Part II trials. Subtract the final pH from the initial pH.
4. Compare the △pH values. Which test gave the largest pH change? Which test gave the smallest pH change?
5. Water from the ocean is said to be "naturally buffered." From the results of this experiment, what does this mean?
6. How does water from the ocean become buffered?
7. 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 acid rain? Explain.
8. There are numerous coal-burning electric power plants along the Ohio River in Southern Indiana, where the river and lake waters are naturally buffered. However, air pollution produced there is more harmful to water life in Upstate New York, where the river and lake waters are NOT buffered than in Southern Indiana. A similar situation exists in Europe where air pollutants from highly industrialized Germany are more harmful to Scandinavian water life than to water life in Germany. Use the results of this experiment to explain these situations.
9. Summarize your conclusions about this laboratory experiment. Use your data to answer the purposes of this experiment.

EXTRA CREDIT

1. Test hard and soft water in the same way you tested lake and ocean water. How do they compare?
2. Do library research to get more information on the effects of acid rain on streams and lakes.
3. Do library research and prepare a report on "naturally buffered" streams and lakes.