Name _____ Class _____ Date_____

Can Lake Life Remain Despite Acid Rain?

Acid Rain and the Chemistry of Lake Water

Question Why does acid rain harm some lakes more than others?

Lab Overview In this investigation you will test how simulated acid rain changes the pH of lake water samples, including a sample of local lake water. You will use your results to make predictions about the effects of acid rain on lake ecosystems and explore how these effects may vary.

Introduction In the Prelab Activity you will compare and contrast three Adirondack lakes that receive significant amounts of acid rain. You will study the characteristics of each lake and develop possible hypotheses explaining why acid rain affects each lake differently.

Background Acid rain is caused by chemical pollutants in the air, mainly sulfur oxides and nitrogen oxides that form when coal and other fossil fuels are burned in factories and cars. These compounds dissolve in rainwater as it falls, forming sulfuric acid and nitric acid. In Chapter 4 you learned that acidity is measured on the pH scale, from 0 to 14. Pure distilled water has a pH of 7.0, which is neutral. Solutions with a pH of less than 7 are acidic. Rainwater in unpolluted environments normally contains small amounts of dissolved carbon dioxide and is slightly acidic, about pH 5.5. Rainwater with a pH lower than 5.5 is considered to be acid rain.

As acid rain falls and collects in lake environments, it can change the pH of the lake water and have a profound impact on plant and animal life. Lake water is a solution containing minerals and salts dissolved from rocks and soil, as well as suspended organic material from decomposed plant and animal life. As these components vary in different locations, so does the natural pH of the lake water in different locations.

Prelab Activity Read the information below about three lakes in the Adirondack Mountains of New York and study Data Table 1 on the next page. Then, answer the Prelab Questions.

The Adirondack lakes, and the woods around them, have long been a popular vacation area. In some of the lakes, aquatic life has been dying off in recent years. Scientists have determined that acid precipitation is one cause. Although there is very little air pollution produced in the Adirondack wilderness, the wind carries air pollutants from surrounding industrial areas to the wilderness.

Data Table 1

Characteristic	Brant Lake	Big Moose Lake	Blue Mountain Lake
Size (approximate)	5.7 km^2	5.2 km^2	5.5 km^2
Elevation (approximate)	243 m	556 m	545 m
Water color	clear	brown	clear
pH	7.6	5.5	7.2
Algae growth	moderate	low	low
Phosphorus levels	low	low	low
Nitrogen levels	low	moderate to high	moderate

Prelab Questions

1. What physical features do Big Moose Lake and Blue Mountain Lake have in common?

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2. What characteristics do Brant Lake and Blue Mountain Lake have in common?

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3. An ecology student noticed that Big Moose Lake has a higher nitrogen level than Brant Lake, but has lower algae growth. This data surprised her, because algae often flourish in water with high nitrogen levels. Develop a hypothesis to explain the surprisingly low algae growth in Big Moose Lake.

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Name _____ Class _____ Date _____

4. In lakes with low pH, such as Big Moose Lake, the normal decomposition of plant and animal debris slows down. How might this explain the difference in appearance between Big Moose Lake and the other two lakes?

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5. The table below shows the pH ranges at which certain aquatic animals can survive. Use the chart to answer the following questions.

Organism	pH 6.5	pH 6.0	pH 5.5	pH 5.0	pH 4.5	pH 4.0
Trout	■	■	■	■		
Bass	■	■	■			
Perch	■	■	■	■	■	
Frogs	■	■	■	■	■	■
Salamanders	■	■	■	■		
Clams	■	■				
Crayfish	■	■	■			
Snails	■	■				
Mayflies	■	■	■			

SOURCE: Environmental Protection Agency, Acid Rain Program

a. Which animal listed in the table is most sensitive to acid rain? Which is least sensitive? Explain.

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b. Based on this data, which animals might you expect to find in Brant Lake that would not be found in Big Moose Lake?

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6. In the lab activity, you will use a chemical called a pH indicator that changes color as the pH of a solution changes. If you added a pH indicator to two different solutions and they both turned the same color, what would this tell you about the pH of each solution?

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Materials

- 5 clear plastic cups or beakers (500-mL size)
- graduated cylinder
- stirring rods or coffee stirrers
- labeling tape
- marker
- 50 mL local lake water*
- 50 mL simulated Brant Lake water
- 50 mL simulated Blue Mountain Lake water
- 50 mL distilled water
- simulated "acid rain" (dilute acetic acid in small beaker or cup)
- transfer pipette
- universal pH indicator

**If local lake water is not available:*
50 mL of local soil, 100 mL tap water, coffee filter, funnel

Procedure 

Part A: Preparing Lake Water Samples

1. **Local lake water sample:** If you have a sample of local lake water, measure 50 mL of it into a plastic cup or beaker. Label the cup or beaker "Local lake water." Then, go to Step 5.

   If you do not have a sample of local lake water, prepare a simulated local lake water sample by following steps 2–4.

2. To prepare a simulated local lake water sample, mix 50 mL of local soil with 100 mL of tap water in a plastic cup or beaker. Stir for 1 min.

3. Line the funnel with the coffee filter. Hold the filter-lined funnel over a clean plastic cup or beaker and carefully pour the soil-water mixture through it.

4. Discard all but 50 mL of the water that has filtered through. Label the cup or beaker "Local lake water."

5. **Other lake water samples:** With a graduated cylinder, measure 50 mL samples of Brant Lake water, Blue Mountain Lake water, and distilled water (for comparison) into separate plastic cups or beakers. Use a paper towel to dry the graduated cylinder between each measurement. Label each cup appropriately.

Part B: Comparing the Effects of Acid Rain on Lake Water Samples

1. Using a transfer pipette, add 1 mL of pH indicator to each cup.

2. Use the pH indicator key to determine the pH of each water sample. Record the data in Data Table 2 on the next page.

Name _____ Class _____ Date_____

3. Add one drop of the "acid rain" to each water sample and stir gently to mix. Note any changes in pH. Record the pH in Data Table 2. Then, add another drop of "acid rain" and repeat.
4. Continue to add "acid rain" two drops at a time while stirring, until all samples have reached pH 4. Keep track of how many drops you have added to each lake sample.

Data Table 2

	Blue Mountain Lake	Brant Lake	Local Lake	Distilled Water
Initial pH of water sample (no acid rain added)				
pH of water sample after 1 drop of acid rain				
pH of water sample after 2 drops of acid rain				
pH of water sample after 4 drops of acid rain				
pH of water sample after 6 drops of acid rain				
Drops of acid rain needed to lower water sample pH to 4				

Analysis and Conclusions

1. To which lake water sample did you add the most acid before it reached pH 4?

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2. Read the following information, then answer the questions that follow.

   Some lakes contain particles of rocks, soil, and decaying plant and animal debris that act as buffers (substances that cause a solution to resist changes in pH). These buffers dissolve in the lake water and then bind to free H^+ ions in an acidic solution (the more acidic a solution is, the more H^+ ions the solution contains). When an H^+ ion binds to a buffer, the ion is no longer free in the solution to affect its pH. However, buffers can only bind to a limited number of H^+ ions.

a. Which of the lake water samples you tested do you think contained the most buffers? Explain.

b. Based on your data and observations, make a prediction about what may happen to this lake in the future, if acid rain continues to fall.

3. How did your local lake water sample resist the effects of the acid rain compared to the other water samples? Why do you think the local lake water compared as it did?

4. Which do you think would have a higher concentration of dissolved minerals, a lake at a higher elevation or a lake at a lower elevation? Explain.

5. Based on the information you discovered in this lab, develop a plan to protect vulnerable lakes from acid rain. Consider factors and questions that should be taken into account before the plan is carried out.

Extension

How could you find out whether or not acid precipitation falls in your local area? Devise a test, and write out the steps of your testing procedure. With your teacher's approval, carry out the testing procedure and report your results to the class.