Plan Your Own Investigation 6-A

Skill Check

- ✓ Initiating and Planning
- ✓ Performing and Recording
- ✓ Analyzing and Interpreting
- ✓ Communicating

What Is Your Exposure to Acids and Bases?

Every day, you are exposed to hundreds of acidic and basic substances. What are their pH values?

Safety Precautions

- Wear safety goggles and a lab apron.
- Use caution when handling substances of unknown pH.
- To avoid contaminating your samples, do not dip pH test strips into the substance to be tested. Instead, transfer a small amount of the material to be tested onto the pH strip.

Materials

- universal indicator or pH paper
- samples of foods, beverages, cosmetics, soaps, and cleaning materials
- other equipment, as needed, to perform tests

Question

How acidic or basic are substances in your everyday life?

Plan and Conduct

1. Your teacher will give you common household substances to investigate. Plan a procedure to identify the pH of each substance.
2. Design a table to record your measurements. Include a title for your table. Make sure you include enough headings and rows in your table to keep all your observations organized.
3. Have your teacher review your procedure and your data table. You must not begin your tests until your teacher has approved your procedure.
4. Perform your tests for the pH of the different substances.
5. Make complete notes for each test.
6. Share your results with your teacher, who will record them in a table on the board.
7. Clean up your work area, and discard any materials as directed by your teacher.

Analyze and Interpret

1. Examine your data table. Look for patterns you can use to group the substances according to pH values. What groupings of substances can you make? Explain what these groupings are based on.
2. Which acids and bases that you are frequently exposed to have the most extreme pH values? Which of these surprise you, and why?

Conclude and Communicate

3. How do you think the pH of a substance is related to how it is used in the home?

Extend Your Inquiry and Research Skills

4. **Inquiry** Design an investigation to use a pH meter to check the measurements that you made using pH paper.

Science Skills

Go to **Science Skills Toolkit 7** for information about creating data tables.

Real World Investigation 6-B

Skill Check

Initiating and Planning

Performing and Recording

✓ **Analyzing and Interpreting**

✓ **Communicating**

The pH of Lakes Near Sudbury

Metals like nickel and copper have been mined in the Sudbury region since 1885. The processes associated with isolating these metals, however, have resulted in the release of sulfur dioxide into the atmosphere. By 1960, over 2×10^6 tonnes of SO_2 were being poured into the air each year. The sulfur dioxide mixed with rainwater and precipitated over wide areas as acid precipitation, leaving thousands of square kilometres with dead and dying lakes and forests. Today, the amount of SO_2 released has been greatly reduced, but about 3×10^5 tonnes are still released each year.

The data below show the mass of sulfur dioxide released from 1973 to 2006 in Sudbury and the pH of three nearby lakes. These lakes are shown on the map on the opposite page. In addition to reducing sulfur dioxide emissions to combat the effects of acid precipitation, two specific treatments have been done: limestone dust was added to Lohi Lake, and crushed limestone was applied to a large area surrounding Hannah Lake.

Math Skills

Go to **Math Skills Toolkit 3** for information about constructing graphs.

pH Data for Lakes Near Sudbury

Year	SO_2 (million tonnes)	Clearwater pH	Hannah pH	Lohi pH
1973	1.48	4.30	4.31	4.45
1975	1.42	4.30	5.33	6.12
1977	1.36	4.10	6.59	5.30
1979	0.50	4.40	7.05	4.70
1981	0.85	4.44	6.62	4.67
1983	0.54	4.57	6.91	4.74
1985	0.78	4.83	7.07	4.71
1987	0.73	4.74	7.15	4.68
1989	0.71	4.69	7.00	4.71
1991	0.64	4.96	7.17	5.00
1993	0.42	5.20	7.21	5.48
1995	0.25	5.52	7.16	6.21
1997	0.29	5.93	7.32	6.32
1999	0.30	6.18	7.44	6.38
2001	0.28	6.29	7.34	6.37
2003	0.30	6.41	7.20	6.40
2005	0.30	6.48	7.25	6.48
2006	0.30	6.61	7.31	6.37

Question

How effective have the methods been to reduce the acidity of lakes in the Sudbury region?

Prediction

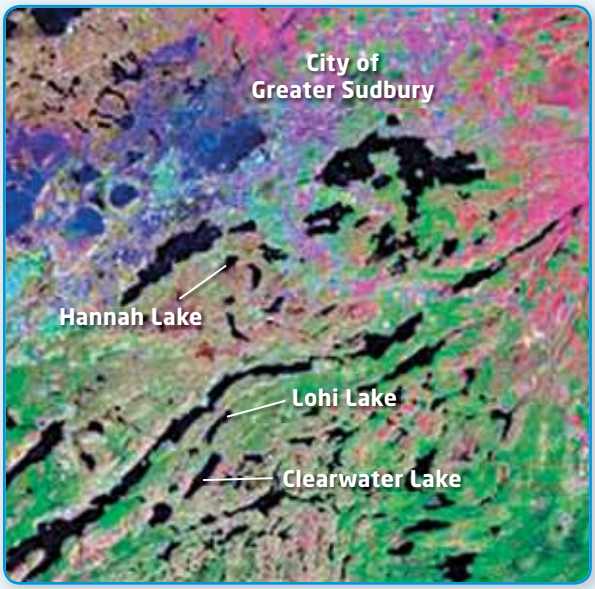
Three separate approaches used to reduce the acidity of lakes in the Sudbury region were

- adding lime, a base, to the lakes to neutralize the acid
- adding lime to the soil around the lakes
- reducing sulfur dioxide emissions

Predict what you think has been the best approach to reducing the acidity of the lakes.

Organize the Data

1. Examine the data in the table. Decide how you will graph the data. Keep in mind that you will need to compare the data from year to year on your graphs. You also want to compare the amount of sulfur dioxide released with the pH of each lake, in addition to comparing the pH values of the different lakes.
2. Draw line graphs of the data, according to your decision in step 1.
3. Label your graphs thoroughly, including titles, axes, units, and any other information you need to communicate the data clearly.



Historically, lakes in the Sudbury area have been acidic.

Analyze and Interpret

1. What was the pH values of the three lakes in 1973? Were they acidic, basic, or neutral?
2. Limestone dust was added to Lohi Lake once to neutralize the acid. In what year was the limestone added? Give reasons for your answer.
3. Crushed limestone was applied to a large area of barren watershed around Hannah Lake to provide soil for the planting of new trees. What effect did that have on the acidity of the lake? Explain your thinking.
4. Clearwater Lake was surrounded by barren watershed after the original trees and vegetation died. Nothing was added to relieve the acidity of the lake. What happened to the pH of Clearwater Lake? Why?

Conclude and Communicate

5. Which was the least effective action taken to reduce acidity? Explain.
6. Which lake showed the most improvement in pH level? Do you think the approach taken for that lake was cost-effective? Explain.
7. Which of the three approaches used will have the greatest overall effect? Explain.

Extend Your Inquiry and Research Skills

8. **Inquiry** There were two kinds of scrubbers built in Sudbury. Examine the graph, and try to determine which years those scrubbers came into operation. Explain your reasoning.
9. **Research** Search Internet or print resources to find the dates of any strikes in Sudbury by mine workers. What effect did the strikes have on sulfur dioxide emissions? What effect did the strikes have on acid levels in the lakes?

Inquiry Investigation 6-C

Neutralizing an Acid with a Base

Antacids, lake renewal, and cleaning chemical spills rely on neutralization reactions between an acid and a base. In this investigation, you will explore acid-base neutralization.

Skill Check

Initiating and Planning

✓ Performing and Recording

✓ Analyzing and Interpreting

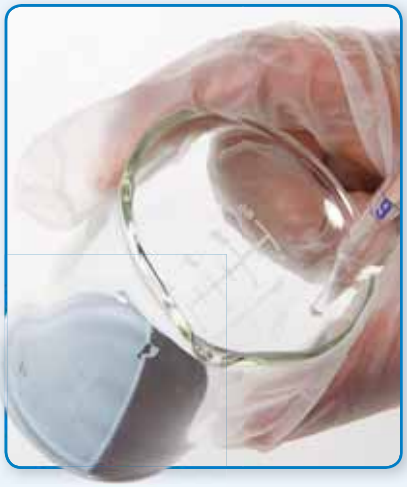
✓ Communicating

Safety Precautions

- Wear safety goggles, gloves, and a lab apron.
- Clean up all spills immediately.

Materials

- two 25 mL graduated cylinders
- 0.1 mol/L hydrochloric acid
- 0.1 mol/L sodium hydroxide
- purple cabbage juice
- two 10 mL pipettes
- pipette bulb or pump
- two 100 mL beakers



Slowly add sodium hydroxide to the cabbage juice and acid in the beaker.

Question

How do an acid and a base neutralize each other?

Procedure

1. Read the procedure, then prepare a table to record your results. Include a title for your table and the units of measurement in the headings.
2. Obtain about 25 mL of hydrochloric acid in one graduated cylinder, and 25 mL sodium hydroxide in the other. Read the volumes to one decimal place, and record the volumes on your table.
3. Add about 1 mL of purple cabbage juice to a beaker. The purple colour you see is the colour of a neutral solution. Use a pipette to transfer about 10 mL of hydrochloric acid to the beaker.
5. Use the second pipette to slowly transfer about 10 mL of sodium hydroxide solution to the beaker. Gently swirl the solution in the beaker as you make the addition. Stop adding the sodium hydroxide as soon as you see a colour change. Use some of the original cabbage juice as a guide for the purple colour that indicates neutrality.
6. Read the remaining volumes of hydrochloric acid and sodium hydroxide on the graduated cylinders, and record them in your table.
7. Calculate the volume of acid and base added in the reaction. Add this to your table.

Analyze and Interpret

1. Compare the quantity of base needed to neutralize the solution with the quantity of acid added. What do you notice?

Conclude and Communicate

2. Write a balanced chemical equation for the neutralization reaction that you observed.

Extend Your Inquiry and Research Skills

3. **Inquiry** If the experiment was repeated using sulfuric acid, H_2SO_4, what do you think would happen? With your teacher's approval, design and conduct an experiment to verify your prediction.