Unit 6 Rain: Acid in Action

CONCEPTS

- Acid has a corrosive effect on many substances.
- Acid rain is a problem for humans, plants, and wildlife.

IDEAS & SUGGESTIONS

Acid rain is a tremendous problem in some areas of the world. In order to understand the ecological effects of acid rain, we must understand the chemical effects of acid.

The white vinegar contains acetic acid. The eggshell and chalk contain calcium compounds that are dissolved by acid.

STUDENT BACKGROUND

Every solution has a pH. The pH scale runs from 0 to 14. Solutions with a pH between 0 and 7 are **acids**, and solutions with a pH between 7 and 14 are **bases**. Solutions with a pH of 7 are **neutral**.

Litmus paper is used to determine whether a solution is acidic or basic. Blue litmus paper turns red in an acid, and red litmus paper turns blue in a base.

TEACHER BACKGROUND

Acid rain is any precipitation with a pH lower than 5.6. Distilled water has a pH of 7. Some lakes and streams are naturally acidic because of dissolved carbon dioxide in the water; other bodies of water are slightly basic. Most aquatic plants grow best in water that is slightly alkaline (pH between 7.0 and 9.0) and cannot thrive when the pH level drops below 6.5. When the pH level of the water drops below 6.0, freshwater shrimp cannot survive; and when the pH drops below 5.0, the eggs of most fish do not hatch. If the pH level of the water drops below 4.5, most aquatic animals die. Acid rain also kills trees, crops, and other vegetation; damages buildings and monuments; reduces the fertility of soil; corrodes copper and lead piping; and can cause toxic metals to leach into underground drinking water sources.

Air pollution from the burning of fossil fuels is the major cause of acid rain. The main air pollutants that create acid rain are sulfur dioxide and nitrogen oxides. Volcanoes, sea spray, and rotting vegetation are all natural sources of sulfur dioxide. The burning of fossil fuels, however, is responsible for approximately half of the worldwide emissions of this gas. When sulfur dioxide reaches the atmosphere, it oxidizes to form a sulfate ion; it then joins with hydrogen atoms in the air and becomes sulfuric acid. The main sources of nitrogen oxides are power stations that burn fossil fuels and the exhaust fumes from vehicles. Once in the atmosphere, nitrogen oxides form nitric acid.

The term **pH** is comes from "potential for Hydrogen." pH is a measure of the strength of an acid or base. The pH scale is logarithmic. A substance with a pH of 3 is 10 times more acidic than a substance with a pH of 4, 100 times more acidic than one with a pH of 5, and 1000 times more acidic than one with a pH of 6. Conversely, a substance with a pH of 11 is 10 times more basic (or alkaline) than one with a pH of 10 and 100 times more basic than one with a pH of 9.

VOCABULARY

acid, acid rain, base, dilution, litmus paper, neutral, pH

Real-World Problem

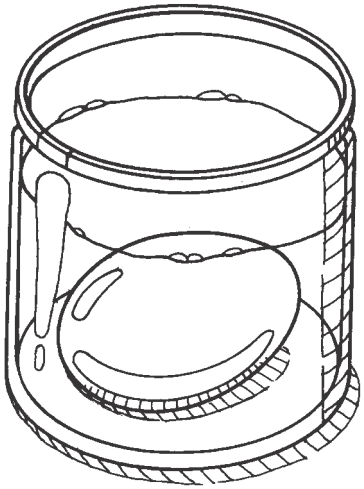
Melting Away

Most acid rain in the United States is a harmful side effect of burning coal in power plants in the Midwest. The acidic chemicals from these plants are carried West to East across the country as gas and dust and fall to the earth in rain and snow. Acid rain can damage trees and can cause breathing problems for children and adults. How can we stop this from happening?

(See page 62 for solution.)

TEACHER DEMONSTRATION

Rain: Acid in Action



You have probably heard about the problem of acid rain when reading about the environment. But what is acid rain, and why is it a problem?

You Will Need

- 2 hard-boiled eggs
- 4 clear glasses
- white vinegar
- 2 pieces of chalk
- blue litmus paper
- distilled water

What to Do

1. Fill two glasses halfway with vinegar and two halfway with distilled water. Label the glasses.
2. Test the vinegar and the water with blue litmus paper to determine whether they are acidic.
3. Show students the hard-boiled eggs and let them touch the shells. What do they think will happen to the egg that sits in water for two days? What will happen to the egg that sits in vinegar for two days? Write students' responses on the board.
4. Show students the chalk. Ask the same questions and record students' predictions.
5. Place one egg in vinegar and one egg in water. Place one piece of chalk in each of the other cups. Place the cups where they will not be disturbed.
6. After two days, remove the egg from the water and allow the students to examine it and touch it gently. Remove the egg from the vinegar, rinse it, and allow the students to examine it and touch it gently.
7. Observe the glasses in which the chalk was placed.

Questions to Ask

What happened to the egg in distilled water? [Nothing; the shell should still be hard.] What happened to the egg in vinegar? [The shell should have become soft and rubbery.] What happened to the chalk in water? [Nothing; the chalk should still be mostly in one solid piece.] What happened to the chalk in vinegar? [It should have dissolved, either completely or into a fine powder.]

What does this experiment have to do with acid rain? [Vinegar is an acid; any effect it has on a substance is the same as the effect acid rain would probably have on the same substance.] Why were an egg and a piece of chalk used? [Both contain calcium and are very similar to the limestone and marble used in the construction of buildings and monuments.]

Ask students if they know what happens to marble and limestone when these materials are exposed to acid rain. What are marble and limestone used to build that can be damaged by acid rain? [Buildings and statues]

POWER OF SCIENCE 2™