Carolina BioKits™

Acid Rain

TEACHER'S MANUAL
AND STUDENT GUIDE

CAROLINA®
World-Class Support for Science & Math

Carolina BioKits™

Acid Rain

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*Photocopy the Student Guide as needed for use in your classroom.

Carolina BioKits™

Acid Rain

NOTES

Overview

In this series of hands-on activities, students learn about the biological, environmental, and chemical mechanisms that are associated with acid rain. First, students determine the pH of unpolluted rain and observe the effects of acid rain on seed germination. Students then investigate the buffering effects of types of bedrock (granite, marble, and basalt) and explore the effects of surface water alkalinity. The series of activities will span the course of four days. This kit contains materials for 30 students working cooperatively in 10 groups of 3.

Objectives

Students will

- estimate the pH of unpolluted rain.
- examine the effects of acid rain on seed germination.
- determine the buffering effects of different types of bedrock (granite, marble, and basalt).
- explain the relationship between surface water alkalinity and pH change.
- test the pH of solutions using pH strips.

Content Standards

To view the national and local standards met by this kit, visit **www.carolina.com/correlations**.

Time Requirements

Preparation . . . . . .50 minutes

Day 1:

Activity 1: Determining the pH of Normal Rainfall . . . . . .10 minutes

Activity 2: Effect of Acid Rain on Seed Germination . . . . .15 minutes

Activity 3: Effect of Bedrock on Acid Rain . . . . . .25 minutes

Day 2:

Activity 2: Effect of Acid Rain on Seed Germination . . . . .5 minutes

Activity 3: Effect of Bedrock on Acid Rain . . . . . .10 minutes

Activity 4: Buffering Capacity of Surface Water . . . . . .20 minutes

Days 3 and 4:

Activity 2: Effect of Acid Rain on Seed Germination . . . . .5 minutes

NOTES

Materials

Included in the kit:

50 petri dishes
50 pieces of filter paper*
bottle of vinegar*
30 plastic vials
30 plastic columns
rubber bands
60 twist ties
14 pipets
10 straws*
sodium bicarbonate, 2 g*
vial of pH test strips*
10 pH color charts
Bogen Universal Indicator with dropper, 15-mL*
Bogen Universal Indicator chart
soil*
plastic wrap*
marble chips, 500 g*
granite chips, 100 g*
basalt chips, 100 g*
radish seeds*
Teacher's Manual and reproducible Student Guide*

*Items included in the Acid Rain refill kit (RN-653076)

Needed, but not supplied:

10 10-mL graduated cylinders
11 50-mL graduated cylinders
20 100-mL beakers or plastic cups
10 50-mL beakers or plastic cups
10 rulers
10 scissors
10 thumbtacks
10 permanent markers
2 1-L bottles for simulated acid rain and buffered water
4 100-mL or larger bottles for vinegar solutions
3 plastic spoons
distilled water (approx. 1500 mL)
350 mL or larger container for distilled water
tap water
paper towels

NOTES

Safety

Use this kit only in accordance with established laboratory safety practices, including appropriate personal protective equipment (PPE) such as gloves, chemical splash goggles, and lab coats or aprons. Ensure that students understand and adhere to these practices. Know and follow all federal, state, and local regulations as well as school district guidelines for the disposal of laboratory wastes. Students should not eat, drink, or chew gum in the lab and should wash their hands before and after entering or exiting the lab.

Bogen Universal Indicator solution may stain skin and clothing. Use caution when working with Bogen Universal Indicator, as it can irritate eyes and skin. It contains ethanol, which is a flammable solvent. Keep flames and sources of ignition away from this solution.

Background

Note: Additional background information can be found in the Student Guide.

Acid Deposition

Despite significant reductions in air pollutant emissions, acid deposition remains a threat to human-made structures, aquatic organisms, forests, and human health. Acid deposition forms when gaseous sulfur dioxide and nitrogen oxides (nitrogen monoxide, nitrogen dioxide, and dinitrogen monoxide) are released into the atmosphere. These gases react with oxygen and water in the atmosphere to form sulfuric and nitric acids and sulfate and nitrate salts.

$$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$$
$$SO_3(g) + H_2O(l) \rightarrow H_2SO_4(aq)$$
$$H_2SO_4(aq) + 2H_2O(l) \rightarrow SO_4^{2-}(aq) + 2H_3O^+(aq)$$

$$NO, NO_2, N_2O(g) + O_2(g) + H_2O(l) \rightarrow HNO_3(aq)$$
$$HNO_3(aq) + H_2O(l) \rightarrow NO_3^-(aq) + H_3O^+(aq)$$

The Hydrologic Cycle

As precipitation falls, carbon dioxide present in the atmosphere dissolves in the water and reacts to form carbonic acid, H_2CO_3, a weak acid. For this reason, unpolluted rainwater is acidic, with a pH value around 5.6.

$$CO_2(g) + H_2O(l) \rightarrow H_2CO_3(aq)$$

When precipitation reaches the ground, it runs off into surface water or infiltrates the soil. The water that infiltrates the soil percolates through permeable rock and into groundwater. Both surface water and groundwater proceed to the ocean. Water returns to the atmosphere when surface water evaporates and plants transpire.

Areas Affected by Acid Deposition

The major sources of sulfur dioxide emitted in the United States are coal-burning electric utilities (70%), whereas the major sources in Canada are industrial plants (60%). The gases rise into the atmosphere where they are carried east and