LESSON 12

What Happens When Substances Are Mixed With Water?

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Why doesn't the sand on this beach mix easily with the water in this lake?

INTRODUCTION

What happens when different substances are mixed with water? Do they all behave in the same way? Does the type of mixture that a substance forms with water depend on the properties of the substance? In this lesson, you will investigate what happens when you mix several pure substances with water. Using your observations, you will identify some of the characteristics of solutions. You will also discuss the terms that are used to describe the formation of solutions.

OBJECTIVES FOR THIS LESSON

Make observations of what happens when different substances are mixed with water.

Identify the characteristics of solutions.

Define and use some terms that describe the parts of a solution and the processes that take place when solutions are formed.

Getting Started

1. Your group will be given a test tube containing a mixture of food coloring and water. In your science notebook, write all the properties of this mixture that you can observe.

2. The class will discuss these observations and relate them to the mixtures you will investigate in this lesson.

3. Return the tube of food coloring to your teacher. Keep the beaker; you can use it to collect water for Inquiry 12.1.

SAFETY TIPS

Wear safety goggles throughout the lesson.

If you splash a solution in your eyes, immediately flush out your eyes with a lot of water and report the accident to your teacher.

Do not mix the contents of different test tubes.

When you complete the inquiry, wash your hands.

MATERIALS FOR LESSON 12

For you

- 1 copy of Student Sheet 12.1: Mixing Substances With Water
- 1 pair of safety goggles

For you and your lab partner

- 1 test tube rack
- 5 test tubes
- 2 rubber stoppers
- 1 lab scoop
- 1 metric ruler
- 1 test tube brush
- Access to water

For your group

- 5 jars containing these substances:
  - Copper (II) sulfate
  - Sodium chloride
  - Zinc oxide
  - Sulfur
  - Confectioners' sugar
- 1 plastic cup
- 1 label

Inquiry 12.1
Adding Water to Substances

PROCEDURE

1. In Inquiry 12.1, you will work in pairs, but you will discuss your results with the other members of your group.

2. One person from your group should collect a plastic box containing the materials. Check the contents of the plastic box against the materials list. You will be sharing the jars containing the substances and the plastic cup with other members of your group, but make sure your pair has one set of the remaining apparatus.

3. You have samples of five different substances. You are going to investigate what happens to each of them when you add water to them.

4. Put one lab scoop of copper (II) sulfate into a test tube.

5. Add water to a depth of 5 cm.

6. Seal the test tube with a rubber stopper.

7. Shake the mixture 10 times. Do not knock the tube against the desk.

8. Examine the contents of the tube (see Figure 12.1). Observe what happens to the solid substance you put in the tube. Write the name of the substance in Table 1 on Student Sheet 12.1. Describe the appearance of the contents in the appropriate space in the table.

9. Repeat the procedure with the remaining four substances.

10. Discuss your results with the other members of your group. Complete the third column of Table 1.

11. Label the plastic cup with the names of the members of your group. Pour the two test tubes of copper (II) sulfate solution into the plastic cup. Store the cup in a safe, warm place. You will look at it again in Lesson 15.

12. Do not clean up your remaining materials until after the class discussion. Put the zinc oxide waste into the container provided. Wash the sulfur down the drain with a lot of water.

Figure 12.1 *Look at your mixture. Is it transparent? Is it of uniform composition? Is it a solution?*

REFLECTING ON WHAT YOU'VE DONE

1. Discuss the results of Inquiry 12.1 with the rest of the class.

2. Observe carefully as your teacher shows you what happens when water is added to potassium permanganate. After the demonstration, write on the student sheet a full description of what happened. Use the terms that have been discussed during the lesson. Look at the terms listed in Step 4 of this section if you are unsure what these words are.

3. Your teacher will repeat the demonstration using sand. Describe your observations as before.

4. On the student sheet, write your definitions of the following terms: soluble, insoluble, solvent, solute, solution, and dissolve.

5. Clean your apparatus and return it to the plastic box.

Dissolving History

The Parthenon stands with other ancient buildings on the Acropolis, which overlooks the city of Athens. These buildings have survived for thousands of years. However, air pollution, caused mainly by motor vehicle exhaust, has greatly damaged them.

Dateline: January 1998, Athens, Greece

A team of archaeologists, architects, ironworkers, and marble cutters has just started a new project. Its goal? To restore the Temple of Athena, a masterpiece of Greek architecture that was built in the fifth century B.C. The surface of the historic monument has been deteriorating for decades. It's time for temple-saving action.

The workers know that they have a hard job ahead. Work on another famous Greek temple, the Parthenon, has been going on for nearly 60 years, and it's not done yet.

These buildings, like many monuments, are built of marble—one of the hardest stones. Why are they in need of restoration?

Wind and rain have always had an effect on buildings, but the main cause of deterioration is pollution. The problem is not just in Athens. In cities around the world, historic buildings are literally being dissolved away.

The major culprits are acid rain and smog (visible as a reddish brown haze), which is a problem in most of the world's large cities. Both originate with the burning of fossil fuels, such as coal and petroleum. As these fuels burn, they give off gases, which include the pollutants sulfur dioxide and nitrogen oxides. One major source of nitrogen oxides is auto exhaust fumes. Sulfur dioxide is produced in particularly large quantities by coal-burning power plants and other industrial operations.

Much of the damage caused to the Parthenon is the result of the action of acid rain dissolving the marble from which it was built.

These gases rise into the atmosphere, where they combine with oxygen and water vapor. The sulfur dioxide becomes sulfuric acid, and the nitric oxides become nitric acid. Together, they form an acid solution that falls to earth as acid rain (or acid sleet or snow).

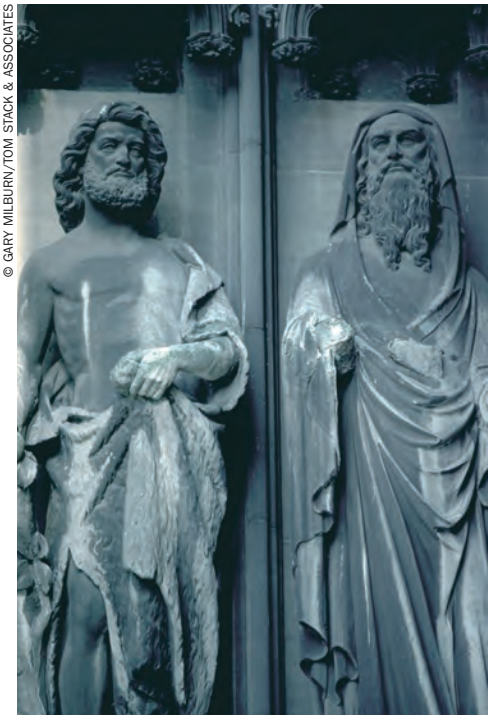
All rain is slightly acidic, but acid rain does much more damage to buildings. It is especially harmful to buildings made from rocks that contain calcium carbonate or magnesium carbonate. Marble, used in many Athenian buildings, and the softer, even more vulnerable, limestone both contain carbonates. As years pass, the acid solution reacts with the surfaces of monuments and buildings and turns them into soluble substances. Acid rain can also attack paint and metals, and it forms a crust on the surface of glass.

Not only does acid rain harm buildings, it damages trees and kills aquatic life and other organisms. To fight these effects, people around the world are applying a great deal of ingenuity to solve the problem of acid rain. In many countries, fossil-fuel-burning power plants and other industrial plants now remove some acidic gases from the waste products that would otherwise be dispersed through smokestacks. Also, special devices are being fitted to car tailpipes to remove some of these gases from exhaust fumes.

This steelworks is belching out smoke and gases, including those that cause acid rain. Pollution as bad as this is no longer allowed in the United States, but it is still common in some other countries of the world.

Despite improved regulation of emissions, motor vehicles are a major source of the air pollution that causes acid rain.

Until the source of the pollution is completely removed, any efforts to restore ancient buildings will be only stopgap measures. The team of workers on the Acropolis in Athens, in other words, is dealing with the symptoms, but not the cure. □



Acid rain has dissolved parts of these statues.

What Can You Do About Acid Rain?

- Use the car less. Carpool, use public transportation, ride a bike, or walk.
- Conserve electricity. Most electricity is produced by coal-burning power plants, and coal emits a high amount of sulfur when it burns.
- Study historical sites, buildings, or cemetery headstones in your area. Try to find out how they have been affected by acid rain.
- Contact a local environmental group to see whether it has taken action about acid rain.

QUESTION

How is acid rain formed? Write a short paragraph describing this process.