

Lesson 3

Recycled Water

How is water recycled?
How does a terrarium demonstrate the water cycle?
How does vinegar simulate acid rain?

GOAL To understand that a terrarium demonstrates the hydrologic cycle

OBJECTIVES

Students will:

- ✓ formulate a hypothesis
- ✓ assemble two terrariums
- ✓ spray one terrarium with vinegar and the other with water
- ✓ observe the effects
- ✓ understand the significance of pH as an indicator of water quality

MATERIALS

two aquarium tanks or large glass jars, five pound bag potting soil, plants, spray mist bottle, plastic wrap, tape or rubber band, observation sheet, vermiculite (optional), activated charcoal (optional), gravel

CORE CURRICULUM CONTENT STANDARDS

- Language Arts 2(2)
- Science 1(1,2,5,6), 3(1,2), 7(6), 8(1-3,6)
- Social Studies 10(2-4), 12(5)

VOCABULARY recycle, hydrologic cycle, acid rain, hypothesis, hydrogen, oxygen

PROCEDURES

1. Using the scientific method of experiment, pose a question to the students and identify a problem. Discuss whether *acid rain* affects plant growth and whether it recycles through the *hydrologic cycle (water cycle)*.
2. Have students confirm or deny the following *hypothesis*: Acid rain will negatively affect plants because it cycles through the hydrologic cycle.
3. Explain to students that they will create two terrariums for their experiment. Label Terrarium number #1 and Terrarium number #2 on the outside of their containers.
4. Students may use a glass jar or aquarium tank. Planting instructions follow:

Planting Instructions:

- **Place a 1/2 inch layer of small gravel in bottom.**
 - **Sprinkle some activated charcoal on top. (Optional)**
 - **Fill to proper height with a good draining potting soil. If soil “clumps” when squeezed, add some Perlite, or Vermiculite to lighten it up. These can usually be found in garden shops.**
 - **Install plants. The number will depend on the size of the plants, and the container. Don’t overplant. Leave room to grow. Push the soil aside, place a plant in the depression, and firm the soil around it.**
 - **Repeat for each plant.**
 - **Water lightly. (3 or 4 ounces; see #'s 5 and 6)**
 - **Cover with plastic wrap and rubber band, or masking tape.**
 - **Repeat exercise for second terrarium.**
5. Spray Terrarium #1 with a mixture of white vinegar and water (½ part vinegar, ½ part water)
 6. Spray Terrarium #2 with water.
 7. Explain to students that spraying terrarium plants with vinegar in Terrarium #1 simulates acid rain (low pH). Spraying water on terrarium plants in Terrarium #2 simulates precipitation.
 8. Discuss pH with students. Because humans and organisms are dependent on water with pH levels near neutral, pH then becomes an important indicator of water quality. Explain that pH measures the concentration of hydrogen ions. A water molecule (H₂O) consists of one hydrogen ion (H⁺) and one hydroxide ion (OH⁻). Simply stated, a solution is more acidic when it contains more hydrogen ions (H⁺). The ions are what give water its ability to bond with and dissolve just about any substance (given the right conditions). On the pH scale, a substance is an acid when it has a low pH and is a base (alkaline) with a high pH.
 9. Ask students what they think vinegar is.
 10. Observe plants for a set amount of time (1 week, 1 month, etc.), continuing to spray plants with appropriate solution. Record observations on data collection sheet (end of lesson).
 11. Ask students how this activity relates to the water cycle (*water evaporates and transpires through plant stomata, becomes water vapor and precipitates*).
 12. Ask what they can conclude. Record conclusions and confirm or deny hypothesis.
 13. Complete scientific method chart.

EXTENSIONS

1. Have students draw the hydrologic cycle in a diagram. Label and explain the process.
2. Have students research the causes of acid rain. Determine what can be done to decrease or eliminate them.
3. Have students test different substances to determine whether they are acidic or basic. Use litmus paper and test solutions such as ammonia, distilled water, baking soda, lemon juice, etc.
4. Have students test the pH level in a stream or river near an area in which they live.

RESOURCES

Etgen, John Healthy Water, Healthy People: Water Quality Educators Guide, 2003, The Watercourse, Bozeman, Montana 59717-0575.

Haskin, Kathleen M., *The Ways of the Watersheds: An Educators Guide to the Environmental and Cultural Dynamics of New York City's Water Supplies*, 1995, Claryville, NY: The Frost Valley YMCA.

GLOSSARY

acid rain - rain containing acids that form in the atmosphere when industrial gas emissions combine with water

hydrogen - colorless, odorless gaseous chemical element; lightest and most abundant element in the universe; present in water and in all organic compounds

hydrologic cycle - the cycle of evaporation and condensation that controls the distribution of the earth's water as it evaporates from bodies of water, condenses, precipitates, and returns to those bodies of water; also called the water cycle

hypothesis - a tentative explanation for an observation, phenomenon, or scientific problem that can be tested by further investigation

oxygen - colorless, odorless gaseous element belonging to group 16 of the periodic table; it is the most abundant element present in the Earth's crust; it also makes up 28% of the Earth's atmosphere

recycle - to extract useful materials from garbage or waste; to extract and reuse useful substances found in waste

Observation Sheet

1. Record your observations of the health of the plants:

	Terrarium 1	Terrarium 2
Week 1		
Week 2		
Week 3		
Week 4		

2. Explain the water cycle based on your observations of the plants.

Scientific Method Chart

Scientific Method Steps	Experiment
Observation Identification of a problem or question	
Hypothesis A prediction of the expected result	
Procedure How hypothesis is tested	
Data Collection and Analysis Take detailed notes of observations	
Conclusions Confirm or deny hypothesis	