# 9-12 THE HYDROLOGIC (WATER) CYCLE

## OBJECTIVES

The student will do the following:

1. Construct a model of the hydrologic cycle.
2. Observe that water is an element of a cycle in the natural environment.
3. Explain how the hydrologic cycle works and why it is important.
4. Compare the hydrologic cycle to other cycles in nature such as nitrogen cycle, carbon cycle.

**SUBJECTS:**
Science (Chemistry, Biology, Earth Science)

**TIME:**
1 class period

**MATERIALS:**
three 1- or 2- liter bottles, two bottle caps
60 cm heavy cotton string (wick)
one clear 35mm film can
soil, water, ice, moss and plant seedstools
to convert bottles: wax pencil, clear tape, scissors, box top, paper punch, tapered reamer, poke, awl, silicone sealant, razor in a safety holder
Plexiglas ™ sheet

## BACKGROUND INFORMATION

Because the Earth is essentially a closed system containing all the water we will ever have, all of this water moves in a pattern called the Hydrologic or Water Cycle. This activity will demonstrate some of the ways water moves through natural systems, how water and the atmosphere are polluted and purified, how the water cycle purifies polluted water, and what role plants and soil have in the processes.

The form of water is always changing. Water moves from sky to Earth and back to the sky again. This is called the water cycle. Water falls to Earth as rain, snow, sleet, or hail. Some of the water soaks into the ground and is stored as groundwater. The rest flows into streams, lakes, rivers, and oceans. The sun warms surface water and changes some of it into water vapor. This process is called evaporation. Plants give off water vapor in a process called transpiration. The heated water vapor rises into the sky and forms clouds. When the vapor in the clouds condenses, it falls back to the Earth as rain or snow. The water cycle has then come full circle and begins again.

The water cycle can be demonstrated using two-liter soft drink bottles and other materials. Through capillary action, water moves up the wick from the bottom bottle unit into the soil. From there it evaporates and becomes water vapor in the central bottle unit. Water vapor exits from plants growing in the bottle through transpiration caused by the evaporation of water from the leaves of the plants. This water vapor is cooled by the ice above that causes it to condense onto the cold surface of the inverted bottle, just as water vapor condenses around particles in the atmosphere and forms clouds. These drops of condensation eventually run down the bottle and flow down the string -- precipitation. Precipitating water then collects in the film can, just as falling rain or snow collects in ponds, lakes, springs, seas, and oceans.

Terms

**capillary action:** the action by which the surface of a liquid where it is in contact with a solid (as in a capillary tube) is elevated or depressed depending on the relative attraction of the molecules of the liquid for each other and for those of the solid

**condensation**: (1) the process of changing from a vapor to a liquid; (2) a liquid obtained by the coming together of a gas or vapor

**evaporate**: to pass off in vapor or in invisible minute particles (to cause evaporation)

**precipitation**: water droplets or ice particles condensed from atmospheric water vapor and sufficiently massive to fall to the Earth's surface, such as rain or snow

**transpiration**: process in which water absorbed by the root systems of plants, moves up through the plants, passes through pores (stomata) in their leaves or other parts, and then evaporates into the atmosphere as water vapor; the passage of water vapor from a living body through a membrane or pores

**water vapor**: water in a gaseous (vapor) form and diffused as in the atmosphere

## ADVANCE PREPARATION

A. Gather the materials and have them laid out for students to use at stations.

B. Caution students on use of scissors.

## PROCEDURE

I. Setting the stage

A. Remove labels from three bottles by using a hair dryer set on low. Hold it about 15cm away from blowing nozzle and move it rapidly up and down so that the air warms the seam of the label.

B. Cut bottle A just below the shoulder or below the curve at the top of the bottle so a straight edge remains on the bottle.

C. Cut B and C bottles just above the hips or above the black bases so bottles have straight sides.

D. Poke a hole in one cap on B. Insert a loop of string (about 40cm) so about 5cm hangs down from the cap.

E. Place a cap with no hole on C. Tie about 20 cm of string around the bottle neck so one end hangs down about 7cm.

II. Activity

A. Introduce and explain the new terms using the chalkboard. Give everyday examples of each term.

B. Build a model that will demonstrate the water cycle.

1. Assemble bottles by placing C upside down in bottle B and B upside down in bottle A. (See diagram.)

2. Thoroughly wet both wicks. This will bring a constant source of water from a reservoir to plant roots. Wicking works by capillary action, the way water moves along fibers of paper towels and cotton string. Add about 150ml of water to A. This is the water source for the cycle. Fill B with enough premoistened soil to cover the loop of the string (200cc or 1 cup). String wick should run up into the soil and not be pressed against side of bottle.

3. Plant two or three seeds of a fast growing plant, such as Chinese cabbage or turnip, in the soil around the perimeter of bottle B. When bottle C isn't being used, leave it off bottle B so that air circulates and seeds can sprout and grow.

4. Place clear film can on top of the soil in center of bottle B so that the wick from bottle C hangs into it. Trim the film can or use a bottle cap if a full-sized can will not fit between bottle C and the soil in bottle B.

5 Fill bottle C with ice water or fill it with water and freeze it. Observe the film can after a few hours.

III. Follow-up

A. Have the students test the water quality in the film can. Test for pH, turbidity, and minerals.

B. Another way to set up a hydrologic cycle would be in an aquarium. One group of students may choose to set up a model this way.

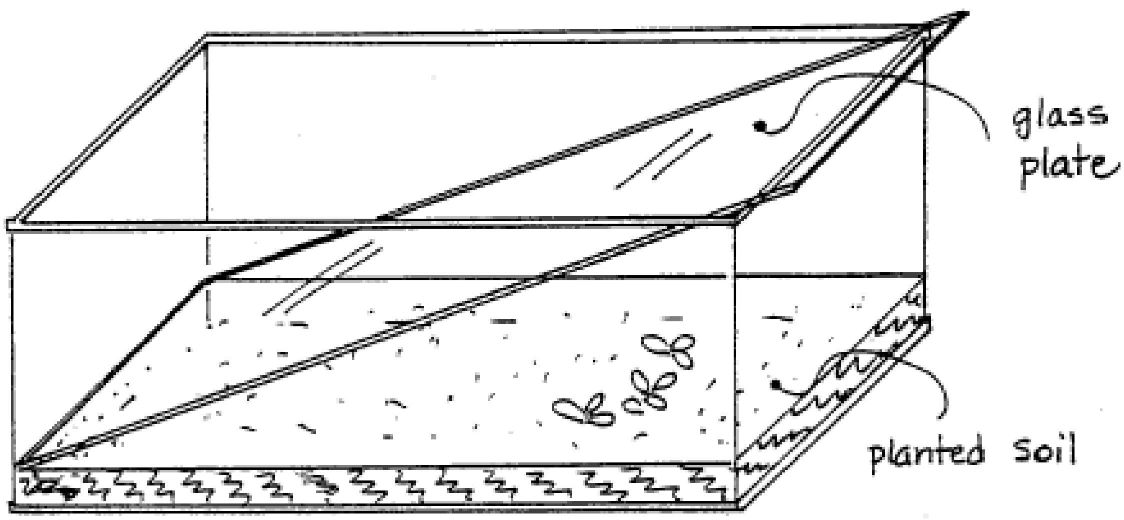
1. In a clean, dry, large aquarium, place a soil mixture in one end so it slopes down towards the other end of the aquarium.

2. Tilt the aquarium so the soil is elevated about 10 cm. Place something under the high end to maintain this position for the entire time (the soil should stay put).

3. Pour the two liters of $H_2O$ into the other end so that a pool is formed.

4. Plant the moss and/or liverworts in the soil end and mist well with a sprayer to dampen the plants and the soil but not enough to form mud.

5. Place the Plexiglas ™ sheet so that it rests on the soil and flush against one end of the aquarium. The other end will rest against the top of the aquarium.




6. Set this near a window that receives indirect (north) light or use a small 2- tube grow light placed over the top of the aquarium.

7. Allow this aquarium, which is now a terrarium, to operate for a day or two. Mark the level of water in the pool.

8. As evaporation occurs from the pool, observe condensation on the diagonal Plexiglas ™ sheet. This will represent clouds. As the condensation becomes heavy, drops will collect and run down to the lower end and into the soil. Mosses/liverworts will represent plants of the Earth. If there are indentations

in the soil, small pools may form that may fill up, overflow, and form streams to the pool (ocean). Some of the water will penetrate the soil and descend to a certain level. This represents groundwater. This water will also eventually go into the pool (ocean). Preparation of the soil could artificially stimulate the cycling to occur. It is suggested that the system be allowed to operate for several days or weeks without artificial manipulation to see if streams will naturally occur.

## RESOURCES


Arms, Karen, Environmental Science, Holt, Rinehart, and Winston, Inc., Austin, TX, 1996.

Chiras, Daniel D., Environmental Science, High School Edition, Addison-Wesley, Menlo Park, CA, 1989.

Nebel, Bernard J. and Richard T. Wright, Environmental Science: The Way The World Works, 4th Edition, Prentice-Hall, Englewood Cliffs, NJ, 1993.

# THE HYDROLOGIC (WATER) CYCLE

1. What part of this experiment demonstrated capillary action?

2. How could you tell that evaporation and transpiration were taking place?

3. What is the difference between evaporation and transpiration?

4. Another name for rain is______________________________.

5. What does the ice do in this experiment?

6. Do you think the water in the film can will contain impurities? Explain your answer.

7. What does the water in the bottom bottle represent?

## THE HYDROLOGIC (WATER) CYCLE

### ANSWER KEY

1. What part of this experiment demonstrated capillary action?
   (String)

2. How could you tell that evaporation and transpiration were taking place?
   (condensation on bottle C and possibly bottle B)

3. What is the difference between evaporation and transpiration?
   (Transpiration is the production of water vapor from a living organism. Evaporation is the formation of a vapor, in this case, water, from any source.)

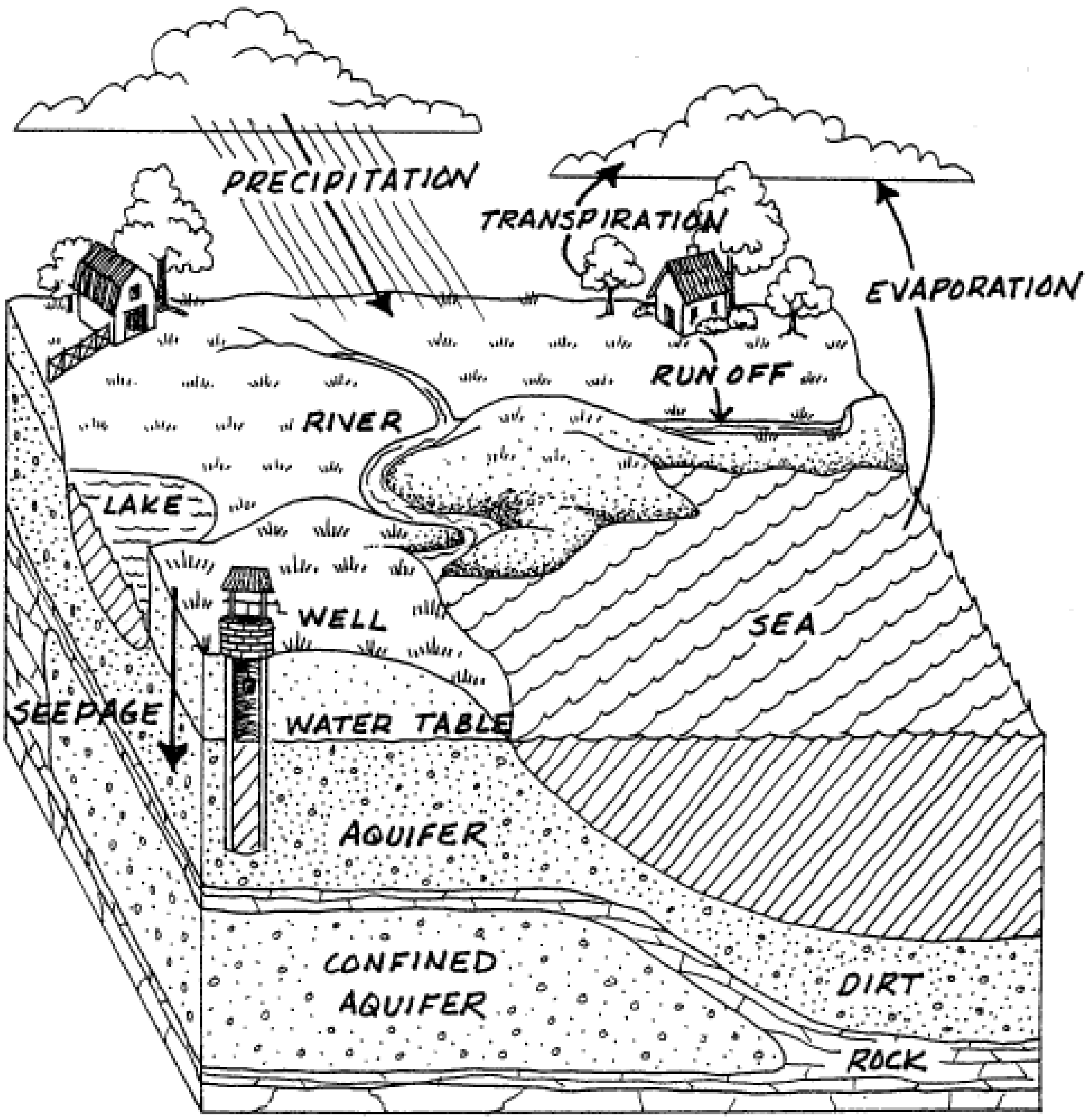
4. Another name for rain is <u>precipitation.</u>

5. What does the ice do in this experiment?
   (causes condensation due to a change in temperature)

6. Do you think the water in the film can will contain impurities? Explain your answer.
   (Not really. When the water evaporates, it does not carry impurities with it. However, it may pick up impurities from the string.)

7. What does the water in the bottom bottle represent?
   (Groundwater)

# THE HYDROLOGIC CYCLE



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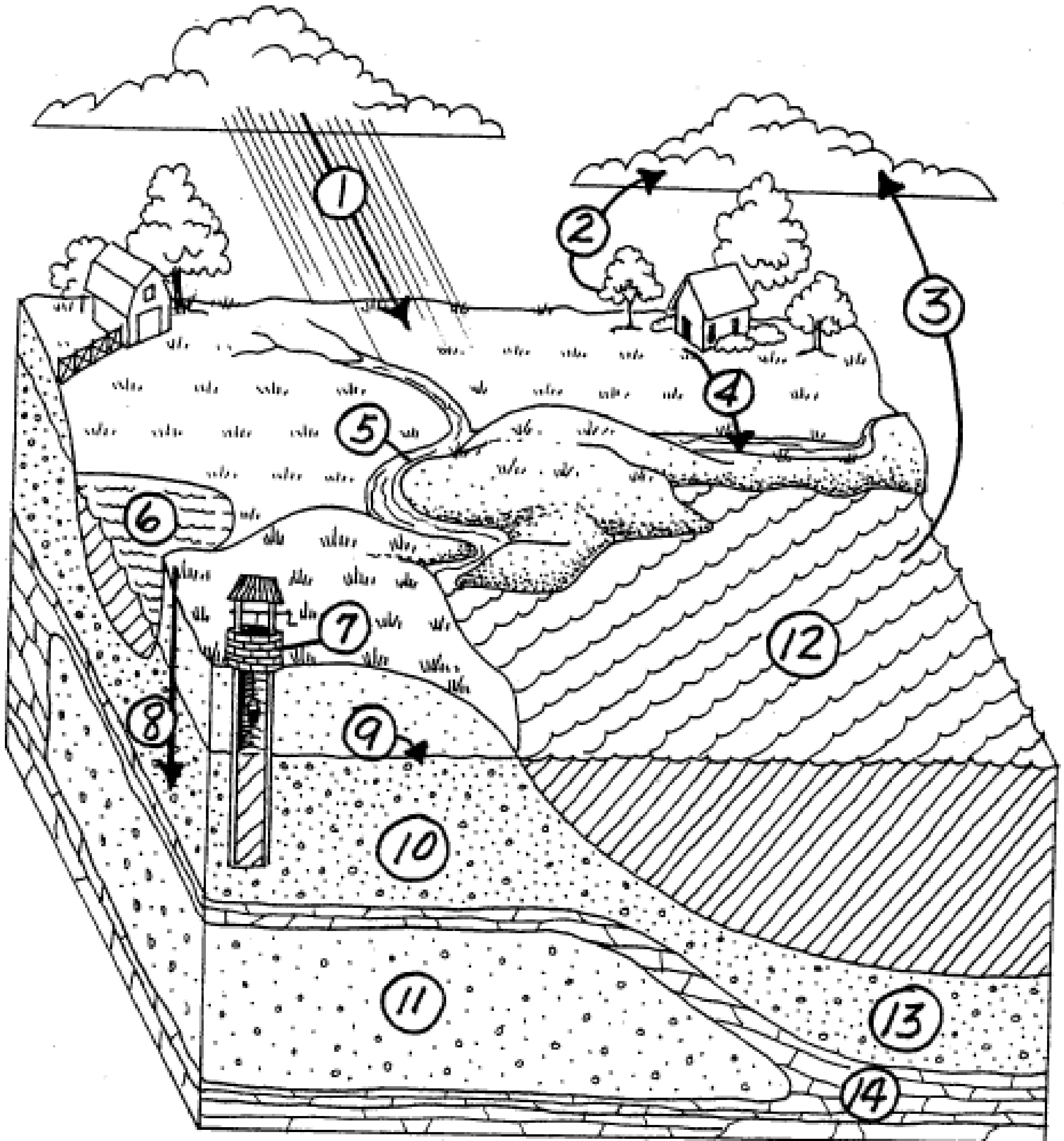


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This is the 15. ______________________ cycle.

# MODEL ASSEMBLY DIRECTIONS