Water cycle

3

"Low anchored cloud,… Fountain-head and source of rivers"
— Henry David Thoreau

Water is the priceless resource on which all growing things depend. Water covers about three-quarters of the earth's surface. Of this, only a small amount is fresh water, less than one-third of which is usable by humans. The rest is locked in the polar ice caps and in glaciers.

Water is continually recycled and transported by the water or hydrologic cycle (Figure 2). The energy for driving this cycle comes from the sun. Water is moved into the atmosphere through two processes, **evaporation** and plant **transpiration**. Transpiration is a specialized form of evaporation. When the sun warms water in the cells of a leaf, it "evaporates." Water vapor also escapes from tiny pores in the leaves of green plants. This is a plant's equivalent to "sweating."

Atmospheric vapor resulting from evaporation

Vocabulary

aquifers
drought
evaporation
flood
ground water
    infiltration
precipitation
rain shadow
runoff
transpiration
water table

Figure 2. Water Cycle

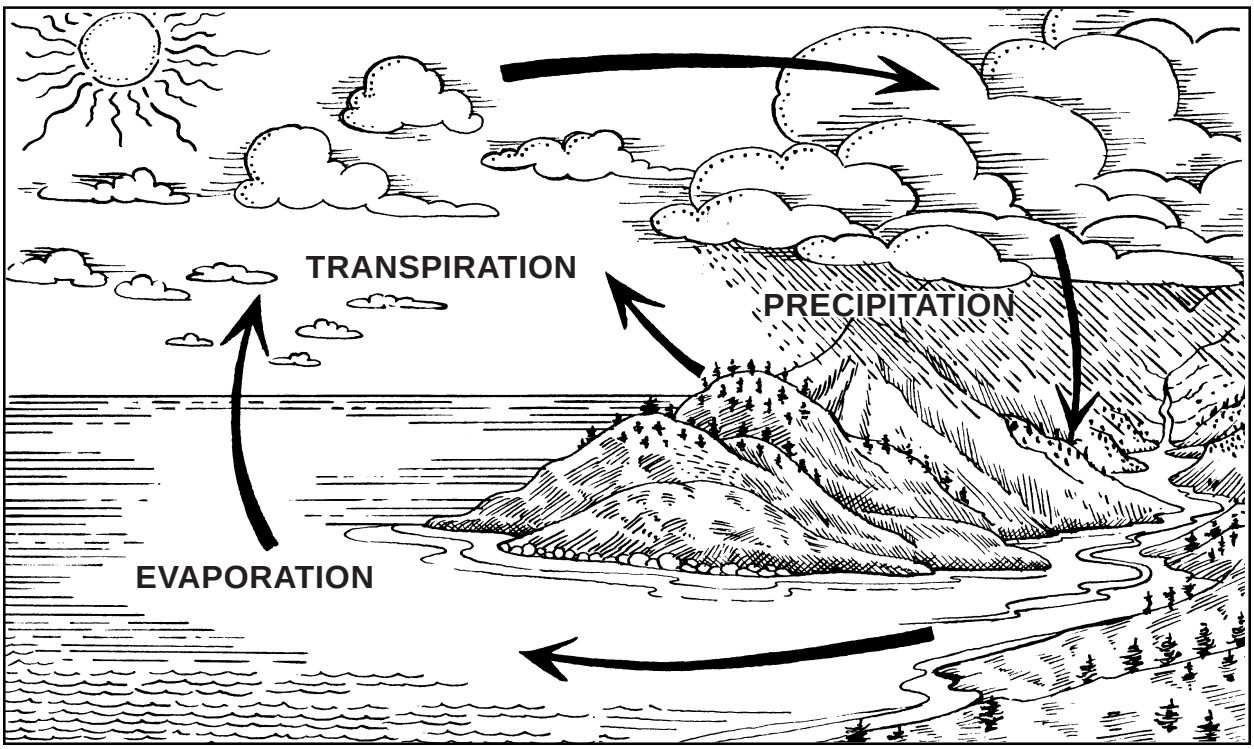
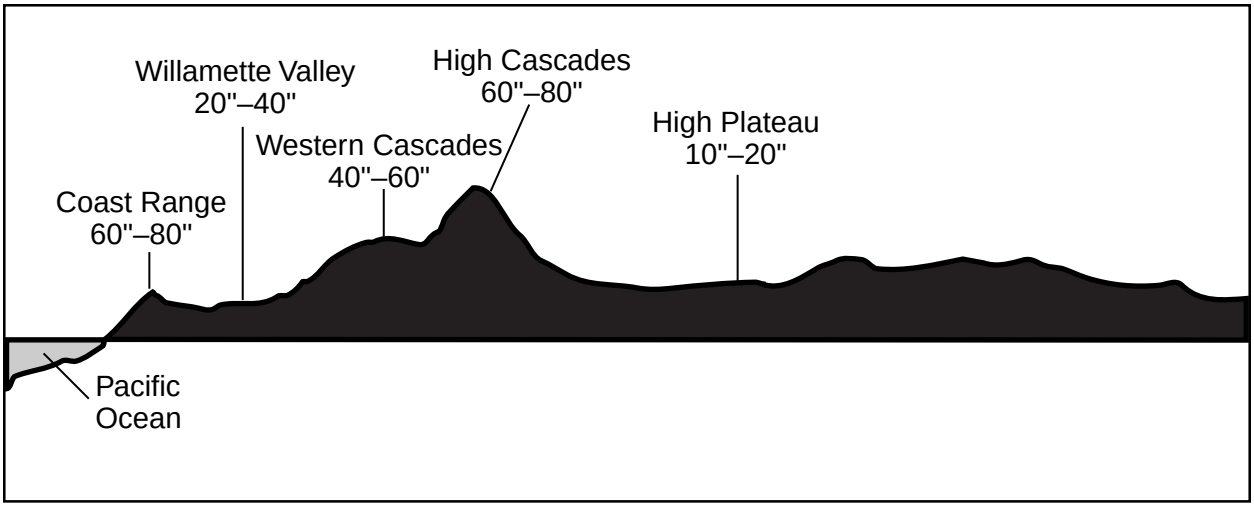


Figure 3. Oregon Average Annual Rainfall



and transpiration is transported by wind, condensed into clouds, and then returned to the earth as **precipitation**. It is estimated that every nine to 12 days, all moisture in the atmosphere falls to earth, making water our most recycled resource.

The largest source of water vapor is evaporation from the oceans, especially those that lie in the warmer parts of the world. The Pacific Ocean is the primary source of water that falls as precipitation on Oregon and the Northwest.

Some of the water that falls as precipitation runs off the land and some soaks into the ground, filling up spaces between soil particles. This is called **ground water infiltration**. Water is moved by gravity through soil and rock layers until it is stopped by solid rock or saturated soil and rock material. Rock or soil areas that hold ground water supplies are called **aquifers**. The top of these aquifers or saturated layers is called the water table. **Water table** levels usually rise and fall as water is added to or removed from the aquifer.

If the upper soil layers are saturated and can no longer hold water, water begins to flow over the land. This overland flow, or **runoff**, collects in surface waters like lakes, ponds, or streams. Unless the receiving water body is in a closed basin (no outlet to the ocean), this water eventually makes its way downstream through an **estuary** and on into the ocean to continue the cycle.

The water cycle is the foundation for examining water in any form. While this process transports and purifies water, its effectiveness may be reduced by such factors as vegetation removal (reducing transpiration) and atmospheric pollution (adding contaminants to otherwise pure vapor).

In Oregon, moisture-laden clouds move from the Pacific Ocean inland (Figure 3). As clouds rise over the Coast Range, their water vapor cools, condenses into drops, and falls as rain. Precipitation continues as the clouds move east, leaving more moisture as they rise over the Cascade Range. Until the clouds reach the Blue, Wallowa, Steens, and other distinct mountain ranges, they are no longer forced to climb into cooler air. Since the Cascades intercept most of the precipitation, a **rainshadow** effect is created in eastern Oregon, making it more arid than the western part.

Extensions

1. "Water Wings," *Aquatic Project WILD*, pp.110. Grades 5-9.
2. "Alice in Waterland," *Aquatic Project WILD*, pp. 151. Grades 5-12.
3. "How Wet is Our Planet?" *Aquatic Project WILD*, pp. 121. Grades 4-12.
4. "Where Does Water Run?" *Aquatic Project WILD*, pp. 21. Grades 6-12.
5. "Nature's Waterwheel," *Groundwater: A Vital Resource*, pp. 9-13. Grades 4-6.
6. "All the Water in the World," *Earth: The Water Planet*, pp. 81-84. Grades 4-8.
7. "Put a Cloud in a Bottle," *Earth: The Water Planet*, pp. 60-62. Grades 4-8.
8. "Little People Water Cycle," *The Comprehensive Water Education Book*, pp. 98-106. Grades K-3.
9. "Clouds," *The Comprehensive Water Education Book*, pp. 107-108. Grades K-3.
10. "Precipitation," *The Comprehensive Water Education Book*, pp. 98-106. Grades K-3.
11. "Rain, Snow, Sleet, and Hail," *The Comprehensive Water Education Book*, pp. 111-115. Grades K-6.
12. "Streams, Lakes, and Rivers," *The Comprehensive Water Education Book*, pp. 116-117. Grades K-6.
13. "Underground Water," *The Comprehensive Water Education Book*, pp. 118-119. Grades K-6.
14. "Where Is It At?" *The Comprehensive Water Education Book*, pp. 120-121. Grades 2-6.
15. "The Water Cycle," *The Comprehensive Water Education Book*, pp. 122-126. Grades 4-6.
16. "Clouds," *The Comprehensive Water Education Book*, pp. 127-130. Grades 3-6.
17. "Precipitation," *The Comprehensive Water Education Book*, pp. 131-134. Grades 4-6.
18. "Transpiration," *The Comprehensive Water Education Book*, pp. 135-136. Grades 4-6.
19. "Water That Come Out of the Ground," *The Comprehensive Water Education Book*, pp. 148-150. Grades 4-6.
20. "The Water Budget," *The Comprehensive Water Education Book*, pp. 153-156. Grades 4-6.
21. "Can Water Move Through Solid Rock?" *Earth: The Water Planet*, pp. 4-7. Grades 4-8.
22. "Is It Full Now?" *Earth: The Water Planet*, pp. 12-16. Grades 4-8.
23. "The Rosa Raindrop Water Cycle Game," *4-H Wetland Wonders*, p. 13. Grades 4-5.
24. "The Water Cycle," *4-H Wetland Wonders*, p. 14. Grades 4-5.
25. "Make A Water Cycle," *Make It Work! Rivers*, p. 9. Grades 4-8.
26. "Water Models," *Project WET,* pp. 201-205. Grades 6-8.

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The water cycle

Activity Education Standards: *Note alignment with Oregon Academic Content Standards beginning on p. 483.*

Objectives

The student will (1) construct a model of the water cycle, (2) simulate the water cycle by using the constructed model, (3) label the diagram and explain the steps of the water cycle, and (4) answer questions relating water to personal and community experiences.

Method

The student will construct a water cycle model, implement the model and describe the steps of the water cycle as they occur.

For younger students

1. Consult extension activities at the end of the water cycle chapter to address the needs of younger students.
2. Read activity background information aloud to younger students or modify for your students' reading level.
3. Set up the water cycle simulation as a teacher demonstration. Answer the questions as a group.

Materials

- 3-lb. coffee can with lid
- small plastic funnel
- 1" diameter rigid plastic tube
- 5, 16-penny nails
- soup can (label removed)
- 12" piece of wire
- ½"×20"×2" piece of wood (support)
- 2"×8"×8" piece of wood (base)
- can of Sterno
- ice
- hot glue and dispenser
- copies of student sheets (pp. 21-24)

Adapted from Southern Willamette Energy Action Team (SWEAT), Eugene, Ore., and used with permission.

Notes to teacher

A potential for burns exists while using the hot glue dispenser and Sterno fuel. Students should be closely supervised and instructed about associated hazards. Be aware of appropriate first aid procedures for burns.

Background

Do you know . . .

The hydrologic (water) cycle is an endless process of water being exchanged among clouds, land and oceans. The amount of water circulating remains about the same but can follow many different routes.

Water molecules from ocean and land surfaces are warmed by the sun and evaporate into the atmosphere as water vapor. At the lower temperature and pressure of high altitudes, the water vapor condenses to produce precipitation (rain, snow, sleet, hail). About seven-eighths of the precipitation falls directly into the oceans.

On land, the precipitation may run off surfaces into lakes, rivers and streams, or infiltrate into the soil or be absorbed by plants. Water not absorbed by plants becomes groundwater that is

Vocabulary

drought
flood

often pumped back to the surface or may eventually emerge from springs. Through transpiration—evaporation of water through plant processes—water is also recycled into the atmosphere.

Weather, climate and geographic features continuously affect the rate and amounts of water circulated between land, ocean and sky. Rain falls more frequently in latitudes closer to the equator and in areas near large bodies of water. Mountain slopes help produce rain clouds by blocking wind currents and causing warm air to be lifted and cooled.

The hydrologic cycle does not distribute water evenly around the earth. When precipitation is low in a certain area and groundwater levels drop, the condition is called a **drought**. When large amounts of water fall in a short time, the land cannot absorb all of it and rivers cannot hold it within their banks. Water pours over the land, causing a **flood**.

The location and availability of fresh water often influence where people settle and populations prosper. Major cities are often located on or near large bodies of fresh water. This provides easy access to the water supply for drinking, industry, transportation, recreation, and agriculture.

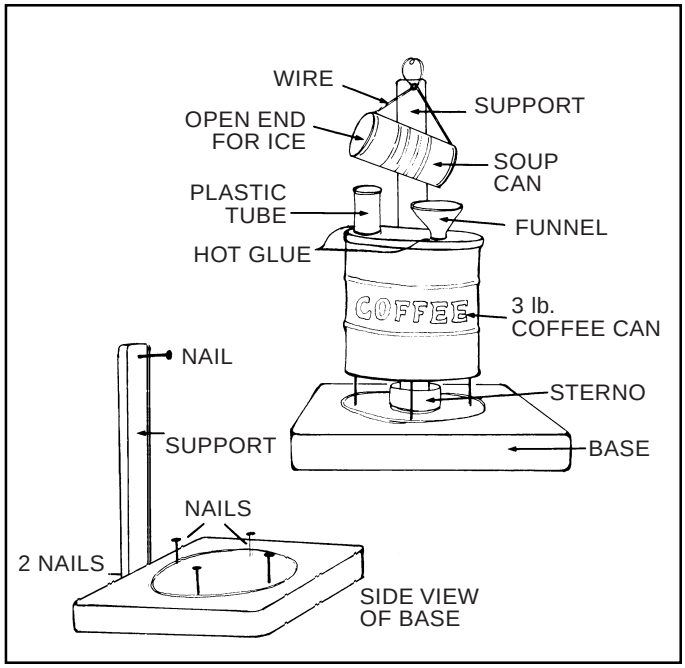
Today, population growth and industrialization throughout the world continue to increase the demand for water. As a result of the great demand and human usage, water can become polluted in several ways—sewage, nutrient chemicals, toxic substances, sediment, and heat. Wise management of this natural resource will determine if we will have the quality (condition of the water) and quantity (amount available for use) to meet future demands.

Procedure

Now it's your turn . . .

How does the water cycle function? In this exercise you will construct the "water cycle" apparatus as shown in the diagram below, or design your own version. Using the completed model you will then simulate the steps in a natural water cycle to demonstrate how the process occurs. Note the following items as you create the model:

- Sterno needs to fit between the wood base and the bottom of the can
- Coffee can needs to sit level on four nails attached to the base
- Hot glue seals and coffee can lid need to be airtight around the base of the funnel and the tube

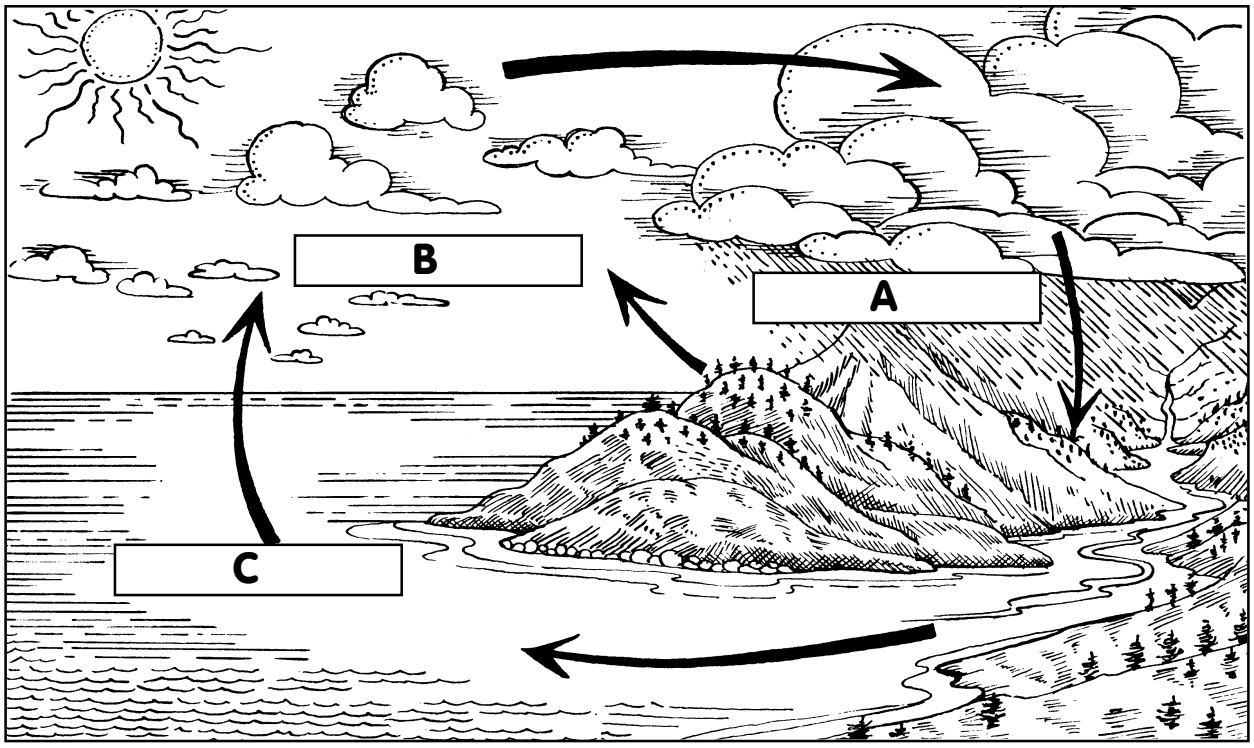


Water cycle simulation

1. Place 1/2" of water in the base of the coffee can.
2. Put one cup of ice cubes in tilted soup can.
3. Light Sterno and place under coffee can.
4. Allow water in coffee can to boil rapidly until steam escapes through chimney (tube). Align the coffee can so the rising steam strikes the soup can just under the opening.

5. Adjust the angle of the soup can so condensing water runs down the length of the can and drips into the funnel.
6. Relate the phase changes of water you have observed to the steps of the water cycle. Label the accompanying diagram and explain what occurs in each step of the water cycle.

Water Cycle



Questions

1. Using letters from the diagram above, label the steps of the water cycle in the blanks provided. Explain what occurs during each step.

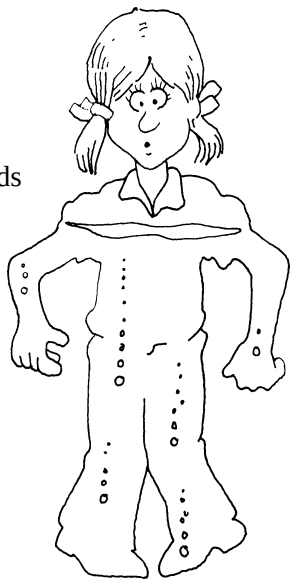
   __***C***__ evaporation __***B***__ transpiration __***A***__ precipitation

2. What physical parts of the model correspond to the steps of the water cycle shown in the diagram above? Does your model demonstrate the entire water cycle? If not, what is missing?

   The coffee can is the body of water. Sterno represents the sun. The coffee can together with the plastic tube represent evaporation of water vapor into the atmosphere. The soup can with ice represents condensation of water vapor and precipitation that falls back into the system. Transpiration and groundwater infiltration are missing from this model.

3. How did the model increase your understanding of the water cycle?

   Answers will vary but should include some comment about water changing form and moving between the earth and the atmosphere.



4. How many gallons of water are you?
   a. Weigh yourself. _____ pounds
   b. Multiply your weight by 2.
   c. Divide your answer by 3. This answer is the approximate number of pounds of water in your body.
   d. A quart of water weighs about 2 pounds, so divide your last answer by 2.
   e. There are 4 quarts in a gallon, so divide again by 4. Therefore, there are _____ gallons of water in your body.
5. What is the average yearly rainfall in your area or community?
   Answers will vary
6. List twenty ways you use water. Underline the ten most important uses to you. Circle the uses that you could not live without.
   Answers will vary
7. Why do people use more water today per person than was used 50 years ago?
   Answers will vary, but should include population growth and industrial uses.
8. Scientists have determined it takes about 1,400 gallons of water to make a meal of a hamburger, french fries, and a soft drink. List at least four ways that water is used to produce this meal.
   Answers will vary
9. Suppose your town is experiencing a water shortage. You are a member of the town council and the mayor asks you to write an emergency plan to save water. List four rules you might make to help your town save water.
   Answers will vary

Going further

1. Using a 2-liter pop bottle, some soil, water and a light, design an apparatus to model the water cycle. Set up a display to demonstrate how your "water cycle" works.
2. Find out where the water supply for your community originates (river, stream, reservoir, well, etc.). If your community gets its water from a river, are there other cities upstream that use the same water source? How might those cities affect the water quality of your water source? If your local water supply comes from a well, find out which aquifer is used. How deep is the aquifer and are there any groundwater problems in the area that may affect your aquifer?
3. Find out how much water is used in your community each day. How is water routed through your community from its source? How does the community store and track water usage and what procedures does it follow in the event of a water shortage? Prepare a report and present the information to the class.
4. Design an experiment that would compare the length of time it would take your school's football field (or an area of lawn) to receive one inch of rainfall if it fell at the same rate as water from a lawn sprinkler. How many gallons of water are needed to give this same area (the football field or patch of lawn) a one inch equivalent of rainfall? Discuss the implications of this amount of water when considering the entire community's water usage during a water shortage period.
5. Allow students to design their own water cycle model (without a diagram) from the listed materials.

Name

The water cycle

Do you know . . .

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The location and availability of fresh water often influence where people settle and populations prosper. Major cities are often located on or near large bodies of fresh water. This provides easy access to the water supply for drinking, industry, transportation, recreation, and agriculture.

Today, population growth and industrialization throughout the world continue to increase the demand for water. As a result of the great demand and human usage, water can become polluted in several ways—sewage, nutrient chemicals, toxic substances, sediment, and heat. Wise management of this natural resource will determine if we will have the quality (condition of the water) and quantity (amount available for use) to meet future demands.

Now it's your turn . . .

How does the water cycle function? In this exercise you will construct the "water cycle" apparatus as shown in the diagram (p. 22), or design your own version. Using the completed model you will then simulate the steps in a natural water cycle to demonstrate how the process occurs. Note the following items as you create the model:

- Sterno needs to fit between the wood base and the bottom of the can
- Coffee can needs to sit level on four nails attached to the base
- Hot glue seals and coffee can lid need to be airtight around the base of the funnel and the tube

Vocabulary

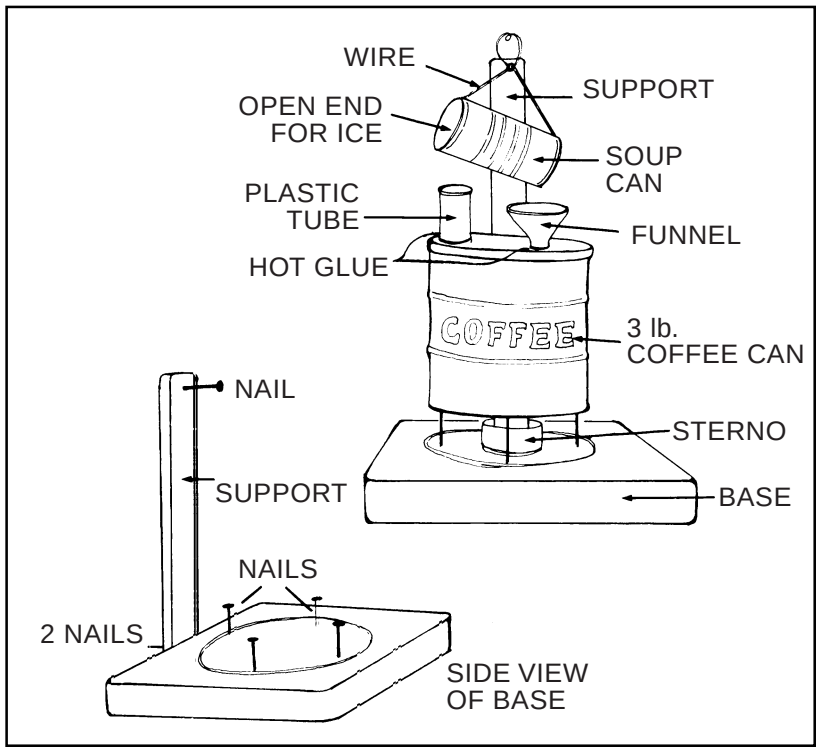
drought
flood

Adapted from Southern Willamette Energy Action Team (SWEAT), Eugene, Ore., and used with permission.

Student sheet

Water cycle simulation

1. Place ½" of water in the base of the coffee can.
2. Put one cup of ice cubes in tilted soup can.
3. Light Sterno and place under coffee can.
4. Allow water in coffee can to boil rapidly until steam escapes through chimney (tube). Align the coffee can so the rising steam strikes the soup can just under the opening.
5. Adjust angle of soup can so condensing water runs down the length of the can and drips into the funnel.
6. Relate the phase changes of water you have observed to the steps of the water cycle. Label the accompanying diagram and explain what occurs in each step of the water cycle.

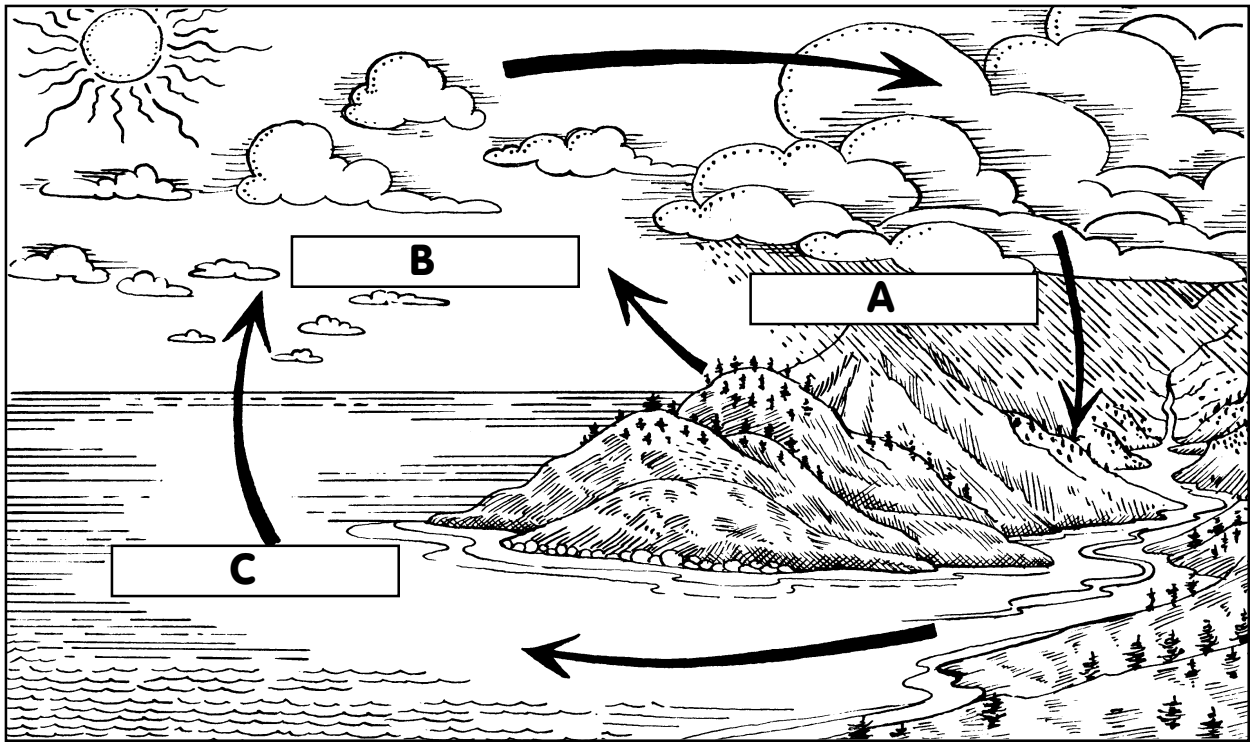


Questions

1. Using letters from the diagram below, label the steps of the water cycle in the blanks provided. Explain what occurs during each step.

   _____ evaporation _____ transpiration _____ precipitation

Water Cycle



2. What physical parts of the model correspond to the steps of the water cycle shown in the diagram above? Does your model demonstrate the entire water cycle? If not, what is missing?

3. How did the model increase your understanding of the water cycle?

4. How many gallons of water are you?

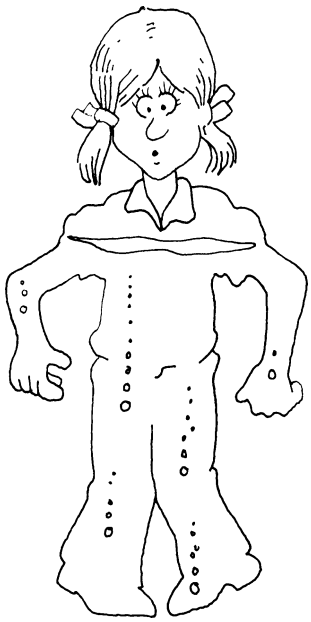
   a. Weigh yourself. _____ pounds

   b. Multiply your weight by 2.

   c. Divide your answer by 3. This answer is the approximate number of pounds of water in your body.

   d. A quart of water weighs about 2 pounds, so divide your last answer by 2.

   e. There are 4 quarts in a gallon, so divide again by 4. Therefore, there are _____ gallons of water in your body.



5. What is the average yearly rainfall in your area or community?

6. List twenty ways you use water. Underline the ten most important uses to you. Circle the uses that you could not live without.

7. Why do people use more water today per person than was used 50 years ago?

8. Scientists have determined it takes about 1,400 gallons of water to make a meal of a hamburger, french fries and a soft drink. List at least four ways that water is used to produce this meal.

9. Suppose your town is experiencing a water shortage. You are a member of the town council and the mayor asks you to write an emergency plan to save water. List four rules you might make to help your town save water.

Water drop crossword puzzle

Activity Education Standards: *Note alignment with Oregon Academic Content Standards beginning on p. 483.*

Objectives

The student will demonstrate familiarity and understanding with the basic concepts of the water cycle by completing the crossword puzzle.

Method

Students will complete the crossword puzzle, with or without the accompanying word list at the teacher's discretion.

For younger students

1. In most cases, younger students will require the word list. Using an overhead transparency of the water cycle while discussing the important concepts as a group may enhance this exercise.
2. Work in pairs or as a group to solve the puzzle. Add the first two "Going Further" activities to help younger students grasp the concepts.

Materials

- crossword puzzle, list of clues, and word list (optional)

Background

Do you know . . .

Although you probably have a good idea about how the basic water cycle works, it took a while for scientists to understand how the parts and processes were all connected. A lot of misinformation led to false beliefs. For instance, during the Middle Ages, people thought that water flowed magically from the center of the earth. Now we know that the total amount of water on the earth remains relatively constant. Water does change from one form to another, but it does not go away. There really is no starting point—like what comes first, the chicken or the egg? The glass of water you drink today may have been in the water that floated Noah's ark or maybe part of the last glassful that George Washington drank.

Procedure

Now it's your turn . . .

Do you understand how the water cycle fits into the "watershed" picture? Can you name and describe the three major processes of the water cycle? What do you know about ground water? Use the following crossword puzzle to test your knowledge about the water cycle and to practice the new words you have learned.

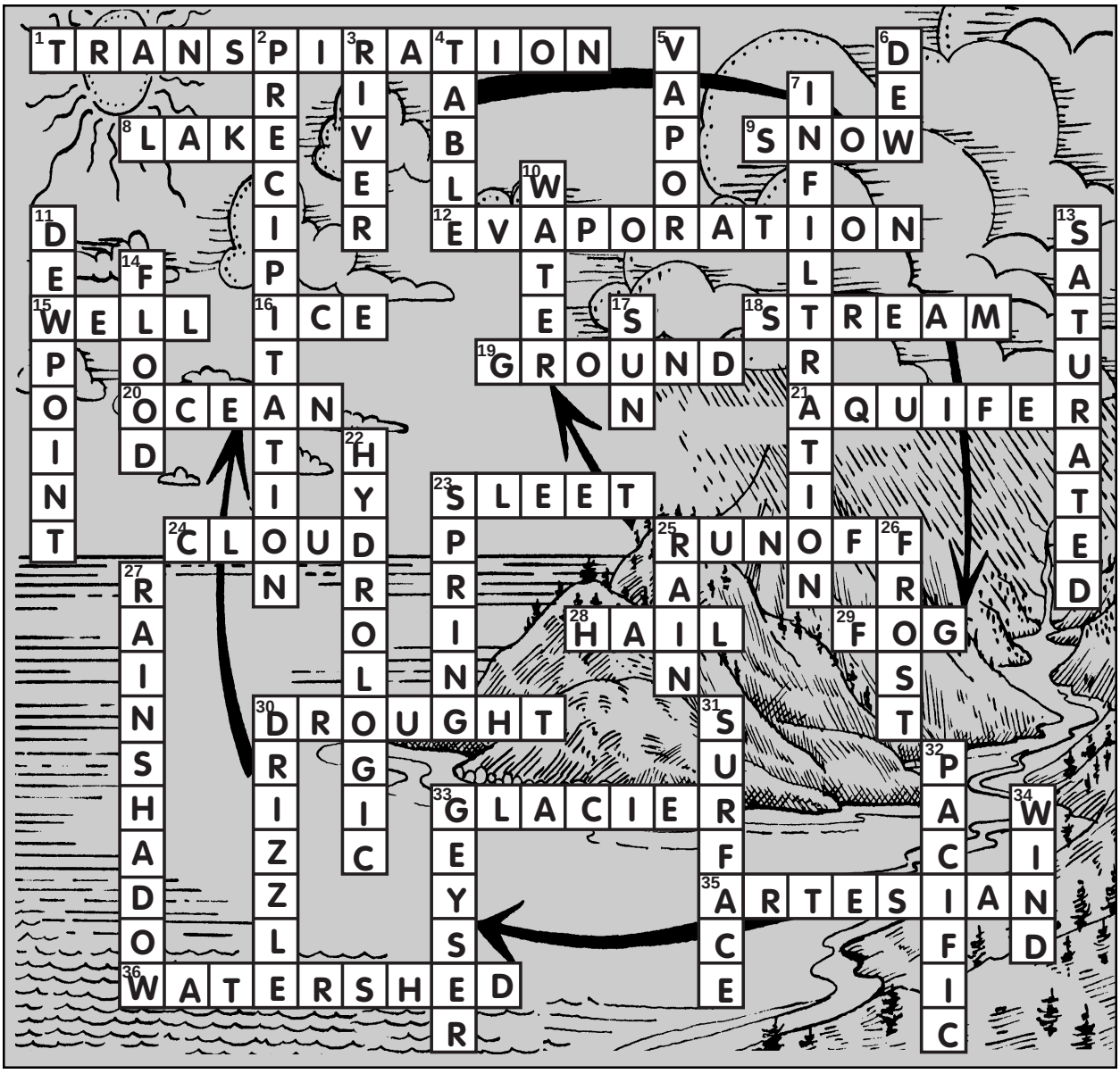
Water drop crossword clues

Across

1. Loss of water from plants through evaporation and as a byproduct of photosynthesis.
8. A _____ is an inland body of water larger than a pond.
9. A form of precipitation that falls to earth as frozen six-sided crystalline flakes.
12. Conversion of water from a liquid form to a vapor.
15. A hole drilled into the earth to get water.
16. Frozen water.
18. A current or flow of water running along the surface of the earth is called a _____.
19. The zone of water infiltration where all the spaces between the rocks and soil particles are filled with water is called _____ water.
20. The largest body of water on the surface of the earth.
21. Layers of porous underground rock that act as water reservoirs.
23. Frozen rain.
24. A large mass of water vapor condensed into billions of fine water droplets is called a _____.
25. Water that drains over the surface of the land.
28. Small rounded pieces of ice that sometimes fall during thunderstorms.
29. A cloud at ground level.
30. Extended period of less than normal precipitation.
33. Large accumulations of ice in the polar areas and at high elevations in the mountains.
35. Well water that flows to the surface under its own natural pressure.
36. All the land area that drains into a particular body of water.

Down

2. Rain, snow, sleet, or hail falling to the ground.
3. A _____ is a natural stream of water, larger than a creek, and often emptying into an ocean or lake.
4. The upper level at which soil is saturated with water is called the water _____.
5. Water _____ is the gaseous form of water.
6. Water vapor condensed into the form of water droplets is called _____.
7. Entry of water into the soil.
10. The _____ cycle is the process of circulating and distributing fresh water on the earth.
11. The temperature at which air is saturated with water vapor.
13. When soils can no longer hold any more water they are called _____.
14. When a stream channel overflows its banks.
17. The energy for driving the water cycle comes from the _____.
22. The _____ cycle is an endless process of water exchange among clouds, land, and oceans.
23. A point at which groundwater comes to the surface.
25. Precipitation in the form of liquid water drops.
26. Frozen water vapor on the earth's surface.
27. An area that receives less precipitation because of its position on the leeward side of a mountain or other landform (two words).
30. Very light rain.
31. Any water flowing or standing on the ground is called _____ water.
32. The _____ Ocean is the primary source of water vapor that falls as precipitation on Oregon and the Northwest.
33. A special type of spring that ejects warm water under pressure into the air.
34. Air movement, called _____, speeds up the process of evaporation.



Word list

aquifer
artesian
cloud
dew
dewpoint
drizzle
drought
evaporation
flood
fog
frost
geyser
glacier
ground
hail
hydrologic
ice
infiltration
lake
ocean
Pacific
precipitation
rain
rain shadow
river
runoff
saturated
sleet
snow
spring
stream
sun
surface
table
transpiration
vapor
water
watershed
well
wind

Going further

1. After working the crossword puzzle, alphabetize all of the words.
2. Write one complete sentence using each word in the crossword puzzle.
3. Create a mural of the water cycle using all the words you learned in the puzzle.

Name

Water drop crossword puzzle

Do you know . . .

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Student sheet

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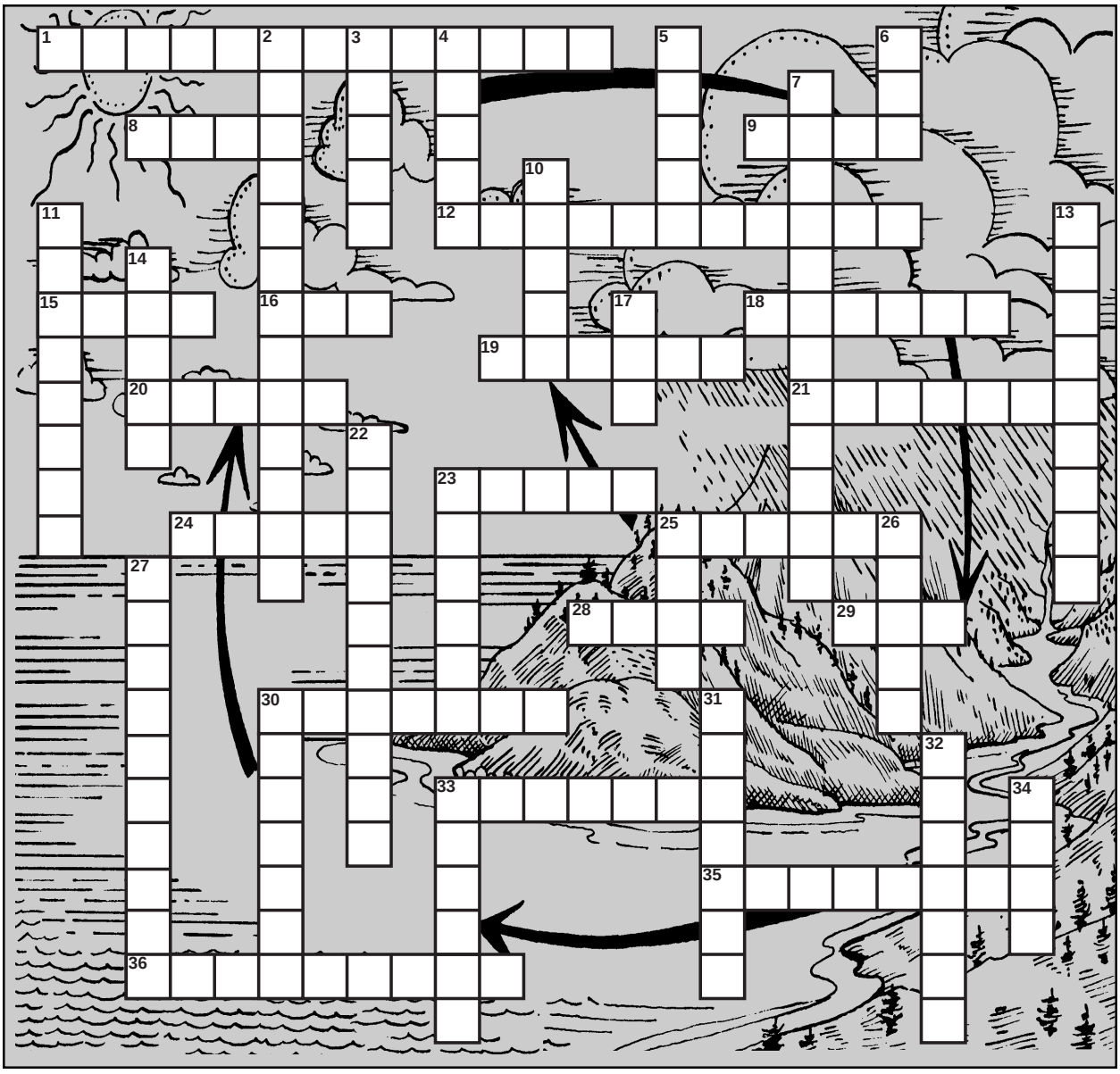
18. A current or flow of water running along the surface of the earth is called a _____.
19. The zone of water infiltration where all the spaces between the rocks and soil particles are filled with water is called _____ water.
20. The largest body of water on the surface of the earth.
21. Layers of porous underground rock that act as water reservoirs.
23. Frozen rain.
24. A large mass of water vapor condensed into billions of fine water droplets is called a _____.
25. Water that drains over the surface of the land.
28. Small rounded pieces of ice that sometimes fall during thunderstorms.
29. A cloud at ground level.
30. Extended period of less than normal precipitation.
33. Large accumulations of ice in the polar areas and at high elevations in the mountains.
35. Well water that flows to the surface under its own natural pressure.
36. All the land area that drains into a particular body of water.

Down

2. Rain, snow, sleet, or hail falling to the ground.
3. A _____ is a natural stream of water, larger than a creek, and often emptying into an ocean or lake.
4. The upper level at which soil is saturated with water is called the water _____.
5. Water _____ is the gaseous form of water.
6. Water vapor condensed into the form of water droplets is called _____.
7. Entry of water into the soil.
10. The _____ cycle is the process of circulating and distributing fresh water on the earth.
11. The temperature at which air is saturated with water vapor.
13. When soils can no longer hold any more water they are called _____.
14. When a stream channel overflows its banks.
17. The energy for driving the water cycle comes from the _____.
22. The _____ cycle is an endless process of water exchange among clouds, land, and oceans.
23. A point at which groundwater comes to the surface.
25. Precipitation in the form of liquid water drops.
26. Frozen water vapor on the earth's surface.
27. An area that receives less precipitation because of its position on the leeward side of a mountain or other landform (two words).
30. Very light rain.
31. Any water flowing or standing on the ground is called _____ water.
32. The _____ Ocean is the primary source of water vapor that falls as precipitation on Oregon and the Northwest.
33. A special type of spring that ejects warm water under pressure into the air.
34. Air movement, called _____, speeds up the process of evaporation.



Word list

glacier	drought	hail	river	surface
well	flood	rain	saturated	table
stream	wind	ice	snow	vapor
transpiration	frost	lake	dew	rain shadow
cloud	geyser	sleet	sun	spring
drizzle	Pacific	ocean	infiltration	hydrologic
aquifer	dewpoint	precipitation	artesian	water
watershed	ground	fog	runoff	evaporation

Student sheet