Where Is All the Water?

Educational Elements

Key Concept:
Water use and conservation habits

Overview:
The *Where is All the Water?* lesson is designed for leaders to help participants understand where water comes from and its unique qualities as well as how to conserve water efficiently. Participants will work in groups to simulate the distribution of water on a global scale and then log their own personal water use.

Age Level: Ages 10 to 14

Life Skills:
Problem solving, critical thinking, wise use of resources, responsible citizenship

Success Indicators:
After completing this lesson, participants should be able to:

- Recognize the distribution of water worldwide.
- Explain some important qualities of water.
- Identify their public water source.
- Calculate personal water use at home and at school.
- Specify the amount of water used by water devices and water practices.
- Name ways to become more water efficient.

Materials & Methods

Preparation Time: 15 minutes

Lesson Time: Two 45-minute sessions

Space: Anywhere

Materials:

- ❒ One gallon jug of water (one for each group of participants)
- ❒ Paper cups (5–10 for each group)
- ❒ Markers
- ❒ "Water Use Quiz Questions" handout (one copy)
- ❒ Scissors
- ❒ "Water Use Chart" worksheet (one for each participant)
- ❒ Newsprint or marker board
- ❒ Measuring cup (one for each group of participants)
- ❒ Teaspoon (one for each group of participants)
- ❒ Eyedropper (one for each group of participants)
- ❒ "The Water Cycle" diagram (one for each group of participants)
- ❒ Pencils (one for each participant)
- ❒ Paper (one for each group)

Background Information:

Water is a necessary component to sustain life. Every living organism requires water to live. Two-thirds of the earth is covered by water, and the human body is composed of approximately 70 percent water. The Great Lakes region is blessed with an abundance of fresh water; 20 percent of the entire world's freshwater is in the Great Lakes and 50 percent of that is in Lake Superior alone. Other parts of the country, such as California where water is rationed, are water deficient. Water is valuable for everyday life, yet we often take water for granted by taking excessively long showers, leaving the faucet on while brushing our teeth, or using the dishwasher for only a few dishes. This water is wasted down the drain! It is helpful to monitor water use and determine what habits can be improved to become more water efficient.

MICHIGAN STATE UNIVERSITY | Extension

Vocabulary:

atmosphere – The mass of air surrounding the earth.

capacity – The potential for holding, storing, or accommodating.

capillary movement – The ability of a liquid to move.

groundwater – Water found under the ground, in aquifers and between soil particles.

hydrologic or water cycle – Cyclical movement of water from the earth (ground, trees and surface water) through the atmosphere and back to earth as precipitation.

polar caps – Dome-shaped sheets of ice covering the North and South poles.

solvent – A substance able to dissolve other substances.

vaporization – The transition of turning a liquid into a gas.

viscosity – The property of water that resists the force that causes it to flow.

Instructions:

Before the Meeting:

1. Review the lesson and gather any supplies you will need.
2. Fill each gallon jug with water. Have the paper cups available to pour different amounts of water into. Label the cups: one for each water source as described in the lesson, except oceans (ice, groundwater, freshwater, other). Prepare a set for each group.
3. Cut out each question from the "Water Use Quiz Questions" handout and save them for distribution to participants in your group.
4. Print enough "Water Use Chart" worksheets for each participant to record individual water use.
5. Obtain the following information from your local municipality:
   - Source of freshwater for public use
   - Number of pump stations – high capacity and other
   - Pump rate for each pump
   - Number of storage tanks
   - Daily water use for municipality in summer and winter
6. On a newsprint or marker board, write the following information:

   World Water Distribution

   97.10 percent = Oceans (saltwater; mostly unusable for human use)

   2.20 percent = Ice (polar caps and glaciers; unavailable for human use)

   .60 percent = Groundwater (only half is available for human use)

   .06 percent = Freshwater lakes/rivers/surface water

   .04 percent = Other (atmosphere, plants, soil, saline lakes, mammals, and more; unavailable for human use)

   On an additional newsprint sheet or marker board, write the following information:

   Representation of Water in Earth's Water Sources
   (One Gallon of Water = 128 oz.)
   Oceans = 124.3 oz.
   Ice = 2.82 oz.
   Groundwater = .768 oz.
   Freshwater = .0768 oz.
   Other = .0512 oz.

During the Meeting:

1. Review the Background Information with participants, and then read aloud or paraphrase the following:

   We need water to live. Most of the world's water is in the ocean and that water is saltwater. Look at the chart showing how the world's water is distributed. We are going to do an activity that will demonstrate the distribution of water available for use.

Divide the large group into smaller groups of two to four. Provide each group with a gallon jug of water. Have participants use the measuring cups, teaspoons, and eyedroppers to begin pouring appropriate amounts of water into paper cups to represent the amount of water in each of the earth's water sources, as outlined on the newsprint or marker board, except for oceans. (It is easier to keep the ocean amount in the jug and pour out the lesser amounts first.)

Examine what is in each cup. Ask participants the following questions:

- *What do you notice about the amounts in the cups?*
- *How much freshwater is available for human use?*
- *How does the freshwater available to humans compare to the total water on Earth?*
- *Do you think there are some locations with an abundance of freshwater? Why or why not? Where?*
- *Do you think there are some locations that need more water for human use? Why or why not? Where?*

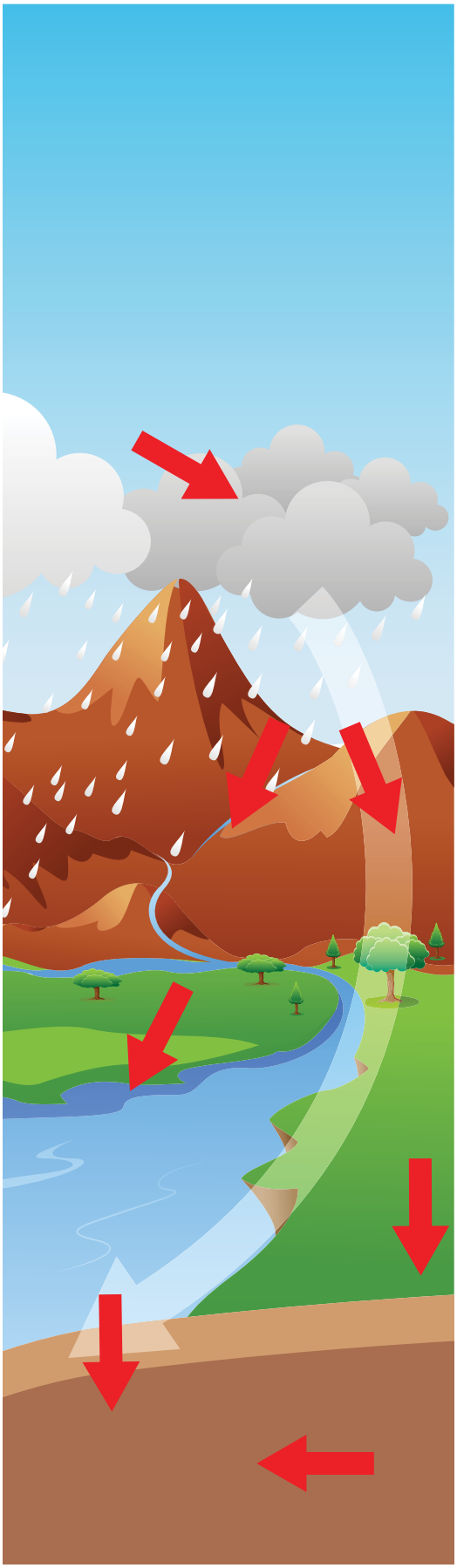
To look at water from a more global perspective, ask the participants more questions:

- *Do you think the total amount of water on Earth and in Earth's atmosphere changes? Why or why not?*
  - Clarify: The amount of water does not change. However, its state and location changes regularly.

Hand out one copy of "The Water Cycle" diagram to each group.

- *What does the water or hydrologic cycle show?* (The movement and recycling of water on, in, and around the earth)
  - Have participants divide into groups of two to four participants. Give each group a piece of paper. Have them quickly diagram a simple water cycle different from what the diagram shows.
  - Have participants identify different components of the water cycle on their drawings and provide arrows to show which way the water moves. Provide a brief explanation to all the groups. Explain that the water cycle does not always follow the same pattern. It will vary depending on many variables including temperature, wind, climate, soil type and other factors.

Continue by explaining that the entire world's water has always been the same amount; there is no new water. Water is constantly being recycled by the hydrologic cycle, or water cycle. Clarify any misunderstanding about the water cycle.



2. Water Quiz: Divide participants into six groups with equal numbers in each group. To each group, provide one question with a given answer that you previously cut from the "Water Use Quiz Questions" handout. Have each group take turns reading their water use question and have the other groups give their best-estimate answer. The group coming closest to the actual answer

earns one point. The group earning the most points is deemed the "Water Logged."

3. Continue by handing out the "Water Use Chart" worksheets, one for each participant. Explain how participants are to record their water usage during a 24-hour period. All water use should be measured including flushing a toilet, washing clothes, drinking from a fountain, taking a shower, cooking, and other uses. Record any water that is used directly by them and also any water they use that is shared, such as cooking, laundry, and other uses. Have them estimate as best they can. For greater accuracy, participants can measure flow per minute from a faucet. They can do this by filling a container for 1 minute to see how much water it contains to determine flow per minute.

The following steps need to be done at a subsequent meeting:

4. Have participants gather in six groups with equal numbers in each. Have members in each group compare their results from their "Water Use Chart" worksheets. Have group members determine the average use for their group for each of the categories listed. List the average amount from each group on newsprint or on the marker board. Next, determine the average amount of water used for each category for the entire group. Ask the whole group the following questions:
   - *Were you surprised by the amount of water you used?*
   - *What was the biggest water user?*
   - *What was the smallest water user?*
   - *Did this cause you to be conscious about your water use?*

5. Have participants try to guess where the water comes from that serves their local municipality and the amount of daily water use. Share the information found from your local municipality regarding the amount of water used and the source of freshwater. Ask the following questions:
   - *Are you surprised by the amount of water used by the (city or town)?*
   - *Where did you think the water came from?*
   - *How does the water get to your house?*
   - *What causes the pressure to make water come from the faucet?*

6. Ask participants to identify some unique qualities of water. After brainstorming, discuss water's unique qualities as described below:
   - High boiling point (100 °Celsius, 212 °Fahrenheit) and high melting/freezing point (0 °Celsius, 32 °Fahrenheit)
     - Otherwise, at normal temperatures water would be a gas.
   - Very high heat of vaporization
     - Otherwise, lakes would dry up at lower temperatures.
   - Extremely high heat capacity
     - Water heats and cools more slowly than other substances.
     - Water is able to absorb heat from much hotter items to cool them down.

- Superior solvent
  - Water dissolves a great variety and quantity of substances.
- Very low viscosity, or resistance to flow
  - Water flows easily and is easy to pump.
- Extremely high surface tension and even higher wetting ability
  - This tension is responsible for capillary movement of water to be drawn upward, or "attraction."
- The only common substance that expands when frozen
  - Ice floats and lakes freeze top down.

Discuss how each quality has an application, and provide examples for each as described above.

Check for Understanding:

Discuss what participants have learned about water, using the following questions as a guide:

- *Since there is always the same amount of water, why should we care about how much water we use?*
- *Is it important to know the source of our freshwater? Why?*
- *Does water use have a cost? Why and what is the cost?*
- *Where do you think water goes when it goes down the drain? (This is a lesson for another day!)*
- *Can you identify some ways water can be conserved?* (Below are examples of possible answers):
  - Turn off the water when brushing teeth.
  - Take shorter showers.
  - Wash full loads of dishes and laundry.
  - Water lawns and gardens at night to avoid evaporation.
  - Install conservation flow faucets.
  - Keep water refrigerated for drinking rather than letting the faucet run to get cold.

Have participants identify one action they will choose to do to help conserve water.

Ways to Extend:

- Explore what water-saving devices are available to reduce water consumption.
- Find out what your school or another public building does to conserve water.
- Ask your family and friends to help you conserve water.

References & Resources:

National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas.* Washington, DC: National Academies Press.

Smart Learning for All. (2014). *Water cycle for kids*. Retrieved from https://www.youtube.com/watch?v=9pqh6tlEOhs

University of California–Davis. (2017). *Unusual properties of water*. Retrieved from the Libretext website https://chem.libretexts.org/Core/Physical_and_Theoretical_Chemistry/Physical_Properties_of_Matter/States_of_Matter/Properties_of_Liquids/Unusual_Properties_of_Water

U.S.G.S. Water Science School. (n.d.). *Summary of the water cycle*. Retrieved from https://water.usgs.gov/edu/watercyclesummary.html

WGBH Educational Foundation. (2006). *Global water distribution*. Retrieved from https://www.pbslearningmedia.org/asset/ess05_int_waterdist/

Acknowledgements:

- **Author:** Nick Baumgart, Environmental and Outdoor Education & Shooting Sports Extension Educator, Michigan State University Extension

Alignment to Science and Engineering Practices

How does 4-H increase science literacy?

Nationally and in Michigan, 4-H has long enjoyed a reputation for engaging young people in positive, experiential (hands-on), and nonformal activities that are inquiry-based. The lessons in the 4-H Science Blast series can be used to enhance classroom science education in Michigan and elsewhere. The lesson activities are aligned with the eight Scientific and Engineering Practices (SEP) from *A Framework for K–12 Science Education* (National Research Council, 2012, p. 42).

The Michigan State Board of Education adopted a set of new state science standards in late 2015 that are based on the SEP. This activity's alignment to the practices was determined by Tracy D'Augustino, Michigan State University Extension educator.

Alignment to the National Research Council Science and Engineering Practices

Science & Engineering Practice	Action	Activity Step
▸ Asking questions and defining problems		
▸ Developing and using models	Participants use the gallon jug and cups of water to represent the distribution of water on earth. Participants use the "The Water Cycle" diagram to explain the components of the water cycle.	During the Meeting 1
▸ Planning and carrying out investigations	Participants observe and record their water use in a 24-hour period.	During the Meeting 3
▸ Analyzing and interpreting data	Participants discuss with their group the average and total water uses.	During the Meeting 4
▸ Using mathematics and computational thinking	Participants calculate their average water use and total water use as individuals and as a small group. Participants calculate the flow per minute of the faucets in their respective houses.	During the Meeting 4
▸ Constructing explanations and designing solutions	Participants use "The Water Cycle" diagram to explain the components of the water cycle.	During the Meeting 1
▸ Engaging in argument from evidence	Participants use evidence or facts to explain why they should care about the amount of water we use.	Check for Understanding
▸ Obtaining, evaluating and communicating information		

Water Use Quiz Questions

How many gallons of water are used when flushing the toilet?

Answer: Older toilets use 3 to 5 gallons per flush.
New toilets use only 1.3 to 1.6 gallons.

How many gallons of water are used when taking a 5-minute shower?

Answer: 10 gallons (Don't forget about the energy used to heat the water!).

How many gallons are used when brushing your teeth with the water running?

Answer: 1 gallon per minute.

How many gallons of water are used to wash a load of laundry?

Answer: 30 to 45 gallons (Don't forget energy for hot water!).

High efficiency washers use much less: 15 to 30 gallons. The most efficient washers use only 5 gallons.

How many gallons of water are used washing dishes?

Answer: Handwashing uses 10 to 20 gallons and high efficiency dishwashers use as little as 4.5 gallons.

How many gallons of water are used when running the garden hose?

Answer: 2.5 gallons per minute.

Water Use Chart

Name _____

	Rate: Gallons per minute	# of times per day	Total gallons	Price per gallon*	Total price
Washing hands					
Brushing teeth					
Taking a shower					
Taking a bath					
Flushing the toilet					
Using a water fountain					
Washing clothes					
Watering lawn/garden					
Cooking					
Washing dishes					
Filling water glass(es)					
TOTAL					

*Price per gallon of water can be obtained from your local utility.

Photograph © iStock.com/PongsakornJun

The Water Cycle

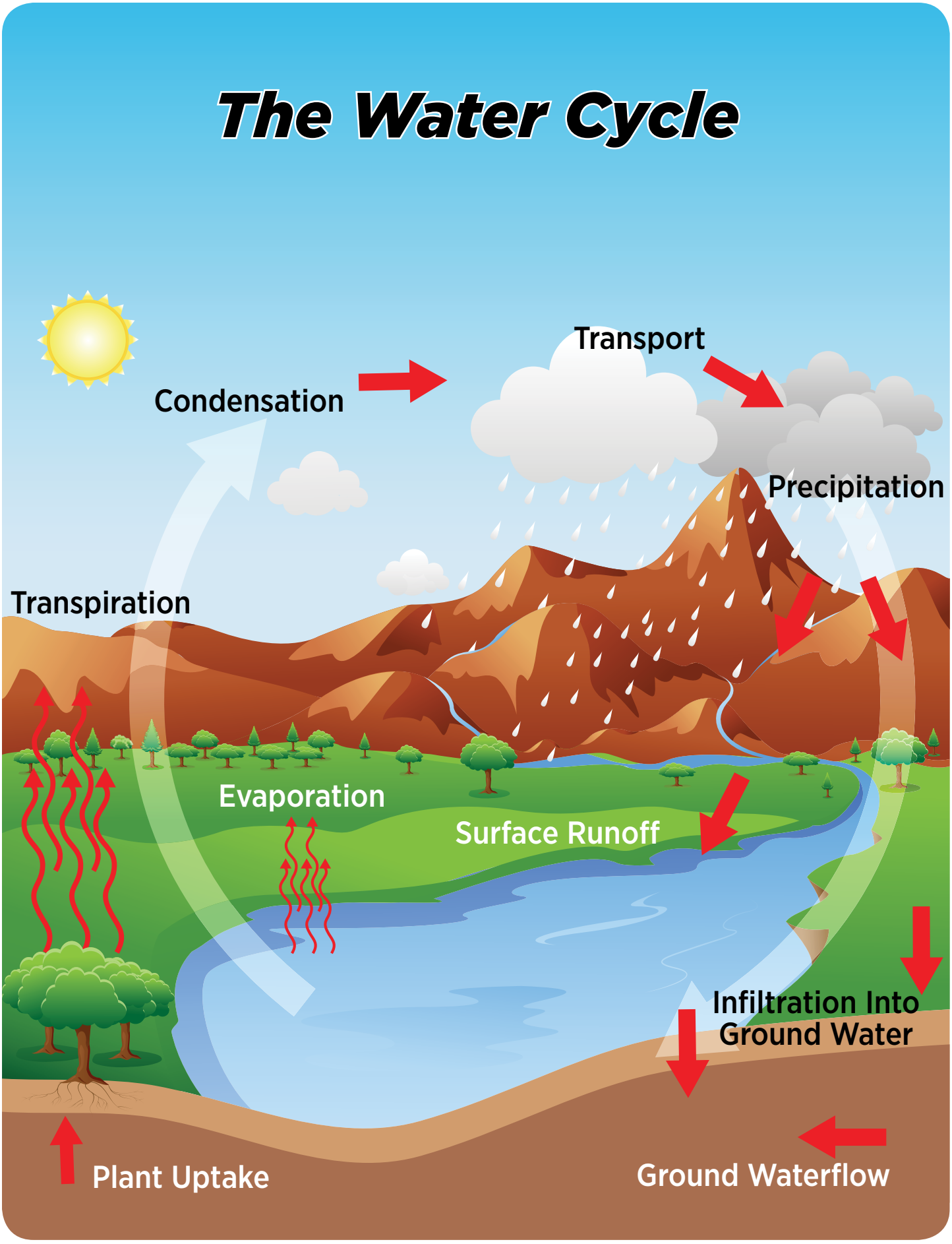


Illustration © iStock.com/stock_shoppe