GENERATIONGENIUS
ALWAYS QUESTION. ALWAYS WONDER.

TEACHER GUIDE

WATER CYCLE
GRADES 6–8

COMMON MISCONCEPTIONS

- **Condensation happens when the molecules of oxygen and hydrogen in the air combine to form water, whereas evaporation happens when the molecules of oxygen and hydrogen of water separate.**
  The molecular structure of water consisting of two hydrogen atoms and one oxygen atom does not change when water changes its state of matter. The state change from liquid to gas or gas to liquid occurs because of changes in temperature. Water condenses from a gas to a liquid when cooled and evaporates from a liquid to a gas when heated, but the molecular structure of water always remains the same.

- **The water droplets that form on the outside of a glass of ice water come from inside the glass.**
  The water droplets that form on the outside of a glass of ice water come from water vapor in the air. When the hot air comes in contact with the cold glass, heat is transferred from the hot air to the cold glass. The loss of heat in the surrounding air causes water vapor by the glass to lose energy. Once the energy is lost, the water vapor condenses into a liquid on the glass.

- **Clouds form when water vapor gets cold.**
  Clouds form when water vapor, an invisible gas, changes states into tiny liquid water droplets by a process called *condensation*. Condensation that forms clouds happens with the help of tiny particles, such as dust, floating in the air that provide surfaces on which water vapor can change into liquid droplets or ice crystals.

CLOUD AND FOG FORMATION

Clouds and fog form when the environmental conditions cause water vapor to condense on tiny particles floating in the air. Dust, salt crystals from sea spray, bacteria, and even ash from volcanoes provides a surface on which water vapor can change into liquid droplets or ice crystals. Different types of clouds form at different altitudes, whereas fog forms only near the ground. A large accumulation of water droplets or ice crystals in the atmosphere is considered a cloud droplet. Clouds are made up of many cloud droplets bundled together with raindrops.

SUN ENERGY

Solar is the Latin word for Sun, and solar energy is a powerful source of energy that comes from the Sun. Solar energy provided by the Sun's rays hitting Earth is one of the driving forces moving water through the water cycle. Heat is one form of energy that we get from solar energy. When heat is added or removed from a system, it can change the state of water.

When water molecules gain energy, they begin to vibrate more and spread out as they bounce off one another. This happens during the process of evaporation when water changes states from a liquid to a vapor. Normally, when molecules of matter lose energy, they vibrate less and become more compact or dense. However, water is an exception. Water has that unique characteristic when it changes states from liquid to a solid. During this process of crystallization, water molecules organize into a specific arrangement that creates additional space between its molecules. This makes solid water (ice) less compact or dense than liquid water.

EVAPORATION VERSUS BOILING

Evaporation is not the only process that can change a substance from a liquid to a gas. The same change can occur through boiling. As a liquid is heated, its molecules absorb heat and move faster. When the liquid starts to boil, bubbles of vapor form within the liquid and rise to the surface. The temperature that causes this to happen is known as the *boiling point* of a liquid.

There are two key differences between evaporation and boiling. The first difference is where the change of state occurs. Evaporation takes place only at the surface of a liquid, whereas boiling may occur throughout the liquid. In boiling, the change of state takes place at any point in the liquid where bubbles form. The bubbles then rise and break at the surface of the liquid. The second difference between evaporation and boiling concerns temperature. Evaporation can take place at any temperature. For example, a puddle of water will evaporate on a cold day, though the rate of evaporation will be slower than it would be on a warm day. In contrast, boiling occurs only at the boiling point of the liquid.

TEACHER TIPS

As students build and draw models of the water cycle, use guiding questions to help facilitate the sensemaking process. Sensemaking is actively trying to figure out how the world works. In this lesson, students will explore the phenomenon of water condensing on the side of a glass of ice water to help them develop an understanding of the science ideas necessary to explain cloud formation within the water cycle.

ABOUT THIS LESSON

This lesson was created by the National Science Teaching Association (NSTA) to pair with the Generation Genius video and support *NGSS*.

They have requested we provide the following background with this lesson:

The Next Generation Science Standards (NGSS) are the national standards on how students learn science, and they are based on contemporary research presented in *A Framework for K–12 Science Education (the Framework).* The shift in science teaching and learning required by the Framework is summarized in this infographic: A New Vision for Science Education.

At the start of each Generation Genius lesson, students are presented with a phenomenon, then they try to explain it. Students will notice they have gaps in their knowledge and ask questions, which motivates them to build ownership of science ideas they need in order to explain how or why the phenomenon occurred. The way students build ownership of science and engineering ideas is through active engagement in the science and engineering practices (SEPs). This process of sensemaking, or doing science to figure out how the world works, is one of the major shifts the *Framework* encourages.

To engage in the SEPs, students should be part of a learning community that allows them to share their ideas, evaluate

competing ideas, give and receive critiques, and reach consensus. Students can start by sharing ideas with a partner, then with a small group, and finally, with the whole class. This strategy creates opportunities for all students to be heard, build confidence, and have something to contribute to whole-class discussions. Each Generation Genius lesson provides conversational supports to facilitate such productive student discussions to contribute to sensemaking.

Excited to continue your shift toward the new vision for science education? Check out the Generation Genius Teacher Guide page on the NSTA website for resources and strategies to engage every student in your classroom in **doing** science.

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