The Water Cycle
Lesson 6b: The Water Cycle

Grade 5	**Length of lesson**: 50 minutes	**Placement of lesson in unit:** 6b of 6 two-part lessons on the water cycle
Unit central questions: How does water change in the world around us? Does Earth ever run out of water?		**Lesson focus question:** Could you be drinking the same water that George Washington used to wash his boots? Explain your thinking.
Main learning goal: Energy from the Sun drives the water cycle, which includes the processes of evaporation, condensation, and precipitation that allow water molecules to move around the world without ever disappearing, being destroyed, or being used up. The total mass of water molecules on Earth doesn't change.		
Science content storyline: Evaporation, condensation, and precipitation are processes that allow water to be continually recycled on Earth. In the water cycle, water molecules are constantly changing states and moving around on Earth and in its atmosphere. Since Earth is a closed system for water molecules, Earth never runs out of water. Although water molecules change states, they never disappear from Earth, lose mass, or are destroyed. Water molecules evaporate when heat is added to liquid water (as when the Sun's energy heats rivers, lakes, and oceans), causing the molecules to gain energy, move faster, break away from other molecules, escape the surface of the water, and spread out into the air as individual water-vapor (gas) molecules. Water-vapor molecules condense when they lose energy in cooler air, slow down, and join together to form tiny droplets of liquid water. Clouds are tiny droplets of liquid (or frozen) water that have condensed onto dust particles in the air. Precipitation occurs when liquid-water droplets in the clouds fall to Earth as rain, hail, sleet, or snow. Each molecule of water changes from one state to another over and over again without ever disappearing or getting used up.		
Ideal student response to the focus question: We could be drinking the same water that George Washington used to wash his boots, because Earth is a closed system for water. This mean that water molecules keep changing states, but they never disappear or get used up. Water molecules on Earth—like in lakes, rivers, the ocean, and puddles—can heat up (gain heat energy) and start moving faster and farther apart and escape into the air as water vapor (evaporation). Some of the water-vapor molecules rise high into the air where it's cooler, and they start to move slower and closer together, forming tiny drops of water on pieces of dust in the air (condensation). These tiny drops of liquid water make up clouds. When the clouds get too full and heavy with water droplets, it rains or snows (precipitation). Each molecule of water moves through these processes of evaporation, condensation, and precipitation over and over and over again, and they never disappear. So the water I drink might contain molecules that were once on George Washington's boots!		

Preparation

Materials Needed • Student notebooks • *Optional:* markers, highlighters, or colored pencils (to mark up handout 6.1) **Student Handouts and Teacher Masters** • 6.1 Travels of the Water Molecules on George Washington's Boots (1 per student) • 6.2 Travels of the Water Molecules on George Washington's Boots (Teacher Master)	**Ahead of Time** • Review the Water Cycle Content Background Document: part 2. • Review the PowerPoint slides and modify them as you wish. • Read the story about George Washington's boots and decide whether to have students (1) read this story individually or as a class; (2) mark the text; and (3) use specific reading strategies. • Decide whether to have students include drawings in their story writing. *Disadvantage:* Students will spend more time on the drawings than the writing. *Advantage:* Drawing is a helpful tool for ELL students. • To support students' story writing, display a word bank that includes these words: *molecules*, *energy*, *gain energy*, *lose energy*, *Sun*, *evaporation*, *condensation*, *precipitation*, *solid*, *liquid*, *gas*, *water vapor*, *mass*, *disappear.* Optional: *freeze*, *melt*.

Lesson 6b General Outline

Time	Phase of Lesson	How the Science Content Storyline Develops
7 min	**Link to previous lesson:** The class reviews findings from the three-bottles experiment about conservation of mass in a closed system. Students compare the bottles with Earth's water cycle and then compare Earth's water cycle with the water-changes system they observed in lesson 4b.	• In a closed system, there is no change in mass as water changes from one state to another. During state changes, water molecules never disappear or get lost or destroyed; they're conserved. • Earth is a closed system for water molecules.
1 min	**Lesson focus question:** The teacher introduces the focus question, *Could you be drinking the same water that George Washington used to wash his boots? Explain your thinking*.	
1 min	**Setup for activity:** The teacher prepares students for reading a story about the travels of some water molecules.	• Water can exist on Earth in three states—liquid, solid, and gas—and change from one state to another (liquid to gas, gas to liquid, liquid to solid, solid to liquid).
15 min	**Activity:** Students read a story about some water molecules that traveled from George Washington's boots in 1776 to the water they drank this morning, and they identify each time the water molecules in the reading changed state.	• In the water cycle, water molecules are constantly changing states and moving around on Earth and in its atmosphere. They continuously change states, but they never disappear from Earth, lose mass, or are destroyed. • Water molecules evaporate when heat is added to liquid water (as when the Sun's energy heats rivers, lakes, and oceans), causing the molecules to gain energy, move faster, and break away from the other molecules, spreading out into the air as individual water-vapor (gas) molecules. • Water-vapor molecules condense when they lose energy in cooler air, slow down, and join together to form tiny droplets of liquid water. • Clouds are tiny droplets of liquid (or solid) water that have condensed onto dust particles in the air. • Precipitation occurs when the liquid-water drops in the clouds fall to Earth as rain, hail, sleet, or snow. • Each molecule of water changes from one state to another over and over without ever disappearing or getting used up.
20 min	**Follow-up to activity:** Students write their own stories about a water molecule traveling from a bucket of water on the playground to California's Lake Arrowhead up in the mountains.	
6 min	**Synthesize/summarize today's lesson**: The teacher helps students check their stories to see whether they included key science ideas about the water cycle. Then the teacher concludes the lesson with a summary statement and a challenge to students to check their understandings.	• Earth is a closed system for water in which water molecules are constantly changing states and moving around on Earth and in its atmosphere. Even though water molecules continuously change states, they never disappear from Earth, lose mass, or are destroyed. So Earth never runs out of water.

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7 min	**Link to Previous Lesson** **Synopsis:** The class reviews findings from the three-bottles experiment about conservation of mass in a closed system. Students compare the bottles to Earth's water cycle and then compare Earth's water cycle with the water-changes system they observed in lesson 4b. **Main science idea(s):** • In a closed system, there is no change in mass as water changes from one state to another. During state changes, water molecules never disappear or get lost or destroyed; they're conserved. • Earth is a closed system for water molecules.	Link science ideas to other science ideas.	**Show slides 1 and 2.** In the last lesson, we investigated what happens in a closed system when water changes from one state to another. What did we discover when we examined the sample data and measured the mass of three bottles of water in the liquid, solid, and gas states? **Show slide 3.** In this unit, we've been exploring two central questions: *How does water change in the world around us?* And *Does Earth ever run out of water?*	The water didn't change. The mass of the water didn't change when the water was frozen or heated. The number of molecules didn't change either. If molecules were lost or destroyed, the mass would have been less.	Can you be more specific? So the mass didn't change. What about the number of molecules? Do you have any evidence to support that?

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			Do you think what we observed in the three-bottles experiment is similar to or different from what happens with water on Earth? Why?	I think it's the same because of the water cycle. I think it's different because Earth doesn't have a cap on it like the bottles. The water vapor can just go up and up and up into space. We said that Earth is a closed system for water, and so are the bottles, so they're the same in that way.	Say more about what you mean when you say, "It's the same because of the water cycle." Does anyone have a different idea? Does anyone agree or disagree?
			Show slide 4. **NOTE TO TEACHER:** *This slide highlights the main idea students should get: All three bottles and*		

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			Earth are closed systems for water. So the bottles in our experiment and Earth are both closed systems for water molecules. Water molecules can change states and move around within the system, but they can never escape or disappear. **Show slide 5.** Now let's look back at our water-changes system. We can think of this system as a model of Earth's water cycle. It doesn't show us *exactly* what happens on Earth, but it does show us something about Earth's water cycle. First, let's see if we can identify what the different parts of the water-changes setup might represent in the real world. **NOTE TO TEACHER:** *Make sure students are thinking of the water-changes setup as it relates to basic elements of Earth's water cycle. For example:* • *Hot plate = Sun* • *Water in flask = bodies of water* • *Tiny liquid-water droplets in flask/tube = clouds* • *Water collected in the test tube = precipitated rainwater* *If students don't make these connections, ask questions like the following.*		
		Select content representations and models matched to the learning goal and engage students in their use.			

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			So what could each part of the setup represent? What in Earth's system is like the hot plate? Why?	The hot plate is like the Sun. Because it adds energy to the system like the Sun.	Why?
			What is like the water in the flask? Why?	The water in the flask is like lakes, rivers, streams, and oceans because it's filled with liquid water.	
			What is like the tiny droplets of liquid water in the tubing? Why?	Clouds.	How are the liquid-water droplets in the tubing like a cloud?
			NOTE TO TEACHER: *The liquid-water droplets in the tubing might be the most challenging comparison for students because they don't look like clouds. The important thing to focus on is the small, condensed drops of liquid water. You can also remind students of the steam they saw coming out of the test tube during this experiment, which obviously looked more like a cloud to them.* What might the water collecting in the test tube	They formed when evaporated water-vapor molecules cooled or lost heat energy.	

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			represent? Why?	Rain. Precipitation in the form of rain.	Where does that happen in Earth's water cycle?
				During Earth's water cycle, this occurs as droplets fall to the surface from storm clouds. In lakes, rivers, streams, and oceans.	
			Now let's think about the strengths and limitations of this model of the water cycle: **Strengths:** How do you think the water-changes system is similar to Earth's water cycle?	It shows water changing from a liquid to a gas (evaporation). It also shows condensation and precipitation.	
			What might this setup model well?	*Ideal response:* It's a good model	

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				of water changing states and cycles in the environment. It shows water molecules traveling in only one direction, not in a cycle.	
			Show slide 6. **Limitations:** How do you think the model is different from Earth's water cycle? What might be some limitations of the model? **CONTENT NOTE TO TEACHER:** *Emphasize that compared to the water-changes setup, water molecules on Earth don't always change in a sequential order from evaporation to condensation to precipitation and then back to evaporation. For example, some molecules might go back and forth between evaporation and condensation repeatedly, without ever rising high enough in the atmosphere to become part of a cloud.*	Some water molecules can escape from the water-changes system but not from Earth. They escape from the top of the test tube. No, because the atmosphere surrounding Earth holds them in.	Where do water molecules escape from the water-changes system? Can't water molecules on Earth escape? What do we call

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			Key idea: A major limitation in the water-changes system is that it's an open system. Some water vapor escaped from the top of the test tube and can't be recycled in the flask. But Earth and its atmosphere are a **closed** system for water molecules, so water is recycled since it can't escape the system. **NOTE TO TEACHER**: *Students may have a difficult time understanding that Earth is a closed system for water. They might think that water evaporating into Earth's atmosphere is the same as water evaporating from the water-changes system into the air.* *Two things might help students understand the difference:* 1. *Ask them, "Is there a way the water vapor that escaped from the test tube can ever end up back in the flask?" [No.] "Can water vapor that evaporates from a lake ever end up back in the lake?" [Yes.]* 2. *Tell students, "You can think of Earth's atmosphere like the caps on our three bottles. It's like a blanket that keeps water molecules from escaping into space.*	Open and closed.	these two types of systems?
1 min	**Lesson Focus Question** **Synopsis:** The teacher introduces the focus question, *Could you be*		**Show slide 7.** Today we're going to answer our central unit questions, *How does water change in the world*		

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	drinking the same water that George Washington used to wash his boots? Explain your thinking.	Set the purpose with a <u>focus question</u> or goal statement.	*around us? Does Earth ever run out of water?* **Show slide 8.** To help us answer those questions, we'll think about our focus question for this lesson: *Could you be drinking the same water that George Washington used to wash his boots? Explain your thinking.* Write this question in your science notebooks and draw a box around it. **NOTE TO TEACHER:** *Also post this question where students can see and refer to it throughout the lesson.* *Don't talk about this question now, since students will address it in the reading (handout 6.1). The story about the travels of water molecules on George Washington's boots will provide students with a model for writing their own stories about how a molecule of water could travel (without human help!) from a bucket of water on the playground to California's Lake Arrowhead up in the mountains.*		
1 min	**Setup for Activity** **Synopsis:** The teacher prepares students for reading a story about the travels of some water molecules. **Main science idea(s):**	Make explicit links between science ideas and activities **before** the activity.	**Show slide 9.** **NOTE TO TEACHER:** *Distribute handout 6.1, Travels of the Water Molecules on George Washington's Boots. The teacher master for this reading highlights the places where water molecules change states in the story.*		

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	• Water can exist on Earth in three states—liquid, solid, and gas—and can change from one state to another (liquid to gas, gas to liquid, liquid to solid, solid to liquid).		Now we're going to read a story about the water molecules on George Washington's boots. This will help us think about our focus question! As we read this story *[individually, in pairs, or as a class]*, I want you to *[notice/mark/highlight]* each time the water molecules from George Washington's boots change state. At the end of the story, you'll count up how many times this happened. What do I mean by "state"? **NOTE TO TEACHER**: *Give students any additional directions for the reading and let them know whether they'll read it individually, in pairs, or as a class. The PowerPoint slide includes suggested directions to guide their reading, but you may want to modify these directions or add something about specific reading strategies you want students to use.*	Like liquid to gas? Solid, liquid, gas	That's an example of a state change. What are the different states of water molecules?
15 min	**Activity** **Synopsis:** Students read a story about some water molecules that traveled from George Washington's boots in	Make explicit links between science ideas and activities **during** the activity.	Now we're going to read about the water molecules on George Washington's boots! Make sure you look for and mark any changes of state you see in the reading. **Student reading time.**		

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	1776 to the water they drank this morning, and they identify each time the water molecules in the reading changed state. **Main science idea(s):** • In the water cycle, water molecules are constantly changing states and moving around on Earth and in its atmosphere. They continuously change states, but they never disappear from Earth, lose mass, or are destroyed. • Water molecules evaporate when heat is added to liquid water (as when the Sun's energy heats rivers, lakes, and oceans), causing the molecules to gain energy, move faster, and break away from the other molecules, spreading out into the air as individual water-vapor (gas) molecules. • Water-vapor molecules condense when they lose energy in cooler		**NOTE TO TEACHER**: *If you read the story aloud as a class, you could stop after each paragraph and ask students if they identified any changes of state in that paragraph. Then ask them to label each change of state as evaporation, condensation, or precipitation.* Take a minute and count up how many times the water molecules from George Washington's boots changed state in the story. **Whole-class discussion:** Now let's talk about the changes of state you identified in the story and how you labeled them. **CONTENT NOTE TO TEACHER**: *There are six changes of state in the story (highlighted in the teacher master). Students may think that precipitation is a change of state. All of the precipitation events in the story involve liquid water in the cloud becoming liquid water as rain. So this isn't a change of state. However, precipitation does sometimes involve a change of state. For example, when the temperature is very low, clouds are made of ice crystals (snow), which is water in a solid state. If water molecules in the solid state (ice crystals) fall through warmer air on the way down to Earth and gain heat energy), they can change to a liquid state. Similarly, water molecules may initially fall from the cloud as liquid water but turn to ice when they encounter colder temperatures*.		

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	air, slow down, and join together to form tiny droplets of liquid water. • Clouds are tiny droplets of liquid (or solid) water that have condensed onto dust particles in the air. • Precipitation occurs when the liquid-water drops in the clouds fall to Earth as rain, hail, sleet, or snow. • Each molecule of water changes from one state to another over and over without ever disappearing or getting used up.				
20 min	**Follow-Up to Activity** **Synopsis:** Students write their own stories about a water molecule traveling from a bucket of water on the playground to California's Lake Arrowhead up in the mountains. **Main science idea(s):** • In the water cycle, water molecules are constantly changing	Make explicit links between science ideas and activities **after** the activity. Engage students in making connections by synthesizing and summarizing key	**Show slide 10.**  ***Embedded Assessment Task*** Now I want you to use what you've learned about Earth's water cycle to write *[and draw]* your own stories about how one water molecule can start from a bucket of water on our playground and end up high in the mountains in Lake Arrowhead. As you're writing your stories, keep in mind that the water molecule has to travel on its own without any help from a person or an animal!		

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	states and moving around on Earth and in its atmosphere. They continuously change states, but they never disappear from Earth, lose mass, or are destroyed. • Water molecules evaporate when heat is added to liquid water (as when the Sun's energy heats rivers, lakes, and oceans), causing the molecules to gain energy, move faster, and break away from the other molecules, spreading out into the air as individual water-vapor (gas) molecules. • Water-vapor molecules condense when they lose energy in cooler air, slow down, and join together to form tiny droplets of liquid water. • Clouds are tiny droplets of liquid (or solid) water that have condensed onto dust particles in the air.	science ideas. Ask questions to probe student ideas and predictions.	Has anyone ever been to the mountains and seen Lake Arrowhead? [*You might want to orient students to where Lake Arrowhead is located and how far away it is.*] **NOTE TO TEACHER:** *Have students use the George Washington story as a model for their own stories about a water molecule traveling from a bucket of water on the playground to Lake Arrowhead.* *You might want to post a special word bank for this task that students can refer to while writing. Include these words:* • *Molecules* • *Energy* • *Gain energy* • *Lose energy* • *Sun* • *Evaporation* • *Condensation* • *Precipitation* • *Solid* • *Liquid* • *Gas* • *Water vapor* • *Mass* • *Disappear* • *Optional: freeze, melt* *As students work, ask **probe questions** to help them clarify their ideas. For example:* • *What do you mean by "it"?* • *You say "water" here. What kind of water*		

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	• Precipitation occurs when the liquid-water drops in the clouds fall to Earth as rain, hail, sleet, or snow. • Each molecule of water changes from one state to another over and over without ever disappearing or getting used up.	Ask questions to challenge student thinking.	*do you mean?* *Ask **challenge questions** to get students using the science terms and ideas developed in these lessons. For example:* • *Can you say more about how the water molecule changes from liquid to gas?* • *Why does the molecule condense?* • *How is the molecule moving when it's (in the cloud, in the bucket, in the lake, in the air)?* • *Can you use the idea of energy in your story?*		
6 min	**Synthesize/Summarize Today's Lesson** **Synopsis:** The teacher helps students check their stories to see whether they included key science ideas about the water cycle. Then the teacher concludes the lesson with a summary statement and a challenge to students to check their understandings. **Main science idea(s):** • Earth is a closed system for water in which water molecules are constantly changing states and moving around on Earth and in its atmosphere. Even	Engage students in making connections by synthesizing and summarizing key science ideas. Summarize key science ideas.	**Show slide 11.** Now that you've finished writing your stories, we're going to list some key science ideas you may have included. As we read through this list, check to see whether each idea appears in your stories. **Optional**: *If time allows, have students revise and/or add to their stories after you review the list.* **NOTE TO TEACHER:** *Read the ideas one by one from the slide:* 1. *A water molecule in the bucket gains enough energy from the Sun to evaporate and rise into the air.* 2. *The evaporated water molecule is now water vapor (a gas) moving throughout the air.* 3. *The water-vapor molecule rises high up in the sky, where it loses heat energy because it's cooler up there.* 4. *The water-vapor molecule slows down and*		

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	though water molecules continuously change states, they never disappear from Earth, lose mass, or are destroyed. So Earth never runs out of water.	Highlight key science ideas and focus question throughout.	*joins with other water molecules to condense and form a tiny water droplet that is part of a cloud.* 5. *The wind blows the cloud over Lake Arrowhead.* 6. *The water molecule joins up with more and more water molecules until it forms a big, heavy drop that falls from the sky as rain and lands in Lake Arrowhead.* **Show slide 12.** **Optional:** Skip slide 12 if time is running short. Our focus question today is *Could you be drinking the same water that George Washington used to wash his boots? Explain your thinking.* Think for a minute about how you would answer this question now. **Individual think time (1 min).** **Whole-class discussion:** Based on everything you've learned about Earth's water cycle in this unit, how would you answer today's focus question? Do you think you could be drinking the same water George Washington used to wash his boots? Why?	Yes, because the water molecules can keep evaporating and condensing over and over again.	

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		Summarize key science ideas.	**Show slide 13.** **NOTE TO TEACHER:** *Point to the unit central questions posted in the room.* Let's revisit our unit central questions: *How does water change in the world around us? Does Earth ever run out of water?* During this unit on the water cycle, we've been developing a **big idea** about how water is constantly changing states on Earth and why Earth never runs out of water. Let's read what the slide says about this big idea. Energy from the Sun drives the water cycle. This cycle includes the processes of evaporation, condensation, and precipitation that allow water molecules to change states and move around Earth and its atmosphere without ever disappearing, losing mass, being destroyed, or being used up. Earth can never run out of water because it's a closed system for water. **Show slide 14 (optional).** **NOTE TO TEACHER:** *If time allows, let students tackle this challenge in a Turn and Talk. Otherwise, just end by presenting this challenge as something to work on later.*	Yes, because water molecules never disappear; they get recycled.	

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			We're going to end this unit on the water cycle with a challenge to see how well you understand the science ideas we've learned about. How would you explain to someone what happens to water molecules in the water cycle during evaporation, condensation, and precipitation?		