The Water Cycle
Lesson 3a: Water Molecules

Grade 5	**Length of lesson:** 40 minutes	**Placement of lesson in unit:** 3a 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:** Why is water sometimes a liquid, sometimes a solid, and sometimes a gas?
Main learning goal: Water is made up of tiny molecules we can't see. In the liquid state, these molecules are always moving around and sliding past one another**.**		
Science content storyline: Why does adding heat help change liquid water to water vapor? And why does cooling help change water vapor to liquid water? To answer these questions, we need to know about water molecules. A water molecule is the tiniest part of water that is still water. It can't be seen, even under a powerful microscope. We can see water only when very large numbers of water molecules cluster together. Water molecules are clustered together in the liquid and solid forms, so we can see liquid water and ice. But water molecules in the gaseous state are so spread out that we can't see them. Even though we can't see individual water molecules, we have evidence from our food-coloring experiment that water molecules in the liquid state move. To answer our focus question, we need to find out whether water molecules in the solid and gaseous states move in the same way.		
Ideal student response to the focus question: To answer the focus question, we need to know more about water. Water is made up of tiny water molecules we can't see, even under a microscope. From observing food coloring in a cup of liquid water, we found evidence that water molecules in the liquid state are moving. Now we need to find out whether water molecules move the same way in the solid (ice) and gas (water-vapor) states.		

Preparation

Materials Needed	**Ahead of Time**
• Science notebooks • Chart-paper diagram of evaporation and condensation from lesson 2b • Photo of a water droplet on a straight-pin head in the book *A Drop of Water*. • A straight pin • 1 clear cup of water for each group (Set the cups where each group can see but not move them. You want the water to be very still.) • Liquid food coloring (red, blue, or green—not yellow) • Walter Wick book, *A Drop of Water*, page 7	• Review the Water Cycle Content Background Document: section 1.1 (especially pages 1–5). • Review the PowerPoint slides and modify them as you wish. • Run through the activity so you know exactly how to add the drop of food coloring to get the desired effect.

Lesson 3a General Outline

Time	Phase of Lesson	How the Science Content Storyline Develops
2 min	**Unit central questions/link to previous lesson:** The teacher revisits the unit central questions and links to science ideas in previous lessons about evaporation and condensation.	• When liquid water is heated, it changes to water vapor (*evaporation*). Water vapor exists in the air all around us, and we can make it change back to liquid water by cooling it (*condensation*).
3 min	**Lesson focus question:** The teacher introduces the focus question, *Why is water sometimes a liquid, sometimes a solid, and sometimes a gas?* and elicits student ideas.	
10 min	**Setup for activity:** The teacher introduces basic ideas about water molecules and sets up an activity adding a drop of food coloring to a cup of water to answer the question, *Do water molecules move?*	• All states of water—solid, liquid, and gas—are made up of water molecules. These water molecules are so tiny that we can't see individual molecules. We can see water molecules only when many of them are clustered together to form a drop of water or a piece of ice.
10 min	**Activity:** Students work in groups to observe the movement of food coloring in a cup of water, draw observations, and discuss in small groups their ideas about what is making the food coloring move in different directions.	
6 min	**Follow-up to activity:** The teacher helps students interpret the food-coloring experiment as evidence that water molecules in the liquid state move.	• We have evidence from our food-coloring experiment that water molecules move in the liquid state.
7 min	**Synthesize/summarize today's lesson:** Students review the focus question and write two new ideas about water in the liquid state.	• Water is made up of tiny molecules we can't see. A water molecule is the tiniest part of water that is still water. • We have evidence from our food-coloring experiment that water molecules move around and slide past one another in the liquid state.
2 min	**Link to next lesson:** The teacher links science ideas to the next lesson.	

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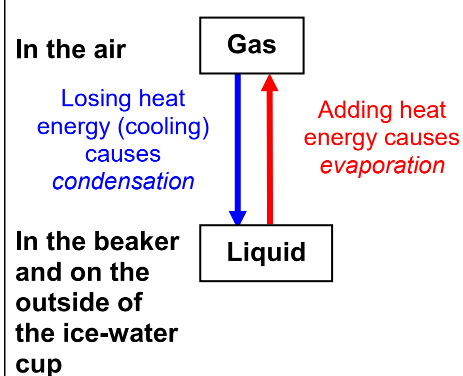
2 min	**Unit Central Questions/Link to Previous Lesson** **Synopsis:** The teacher revisits the unit central questions and links to science ideas in previous lessons about evaporation and condensation. **Main science idea(s):** • When liquid water is heated, it changes to water vapor (*evaporation*). Water vapor exists in the air all around us, and we can make it change back to liquid water by cooling it (*condensation*).	Link science ideas to other science ideas. Summarize key science ideas.	**Show slides 1 and 2.** One of the big questions we're studying in this unit on the water cycle is *How does water change in the world around us?* So far we've observed and explained two changes. **Show slide 3.** **NOTE TO TEACHER:** *As you talk, point to the diagram from lesson 2b:* We learned that when liquid water is heated, it changes to water vapor. Water vapor exists in the air all around us, and we can make it change back to liquid water by cooling it.  Understanding how liquid water is similar to and different from water in the gaseous state (water vapor) is important for understanding what happens when water changes state.		
3 min	**Lesson Focus Question**		**Show slide 4.**		

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	Synopsis: The teacher introduces the focus question, *Why is water sometimes a liquid, sometimes a solid, and sometimes a gas?* and elicits student ideas.	Set the purpose with a focus question or goal statement. Ask questions to elicit student ideas and predictions.	So our focus question for today is *Why is water sometimes a liquid, sometimes a solid, and sometimes a gas?* Write this question in your science notebooks and draw a box around it. What ideas do you have about this focus question? **NOTE TO TEACHER:** *Listen to student ideas. What's visible about student thinking? Do students bring up ideas about molecules? They may not have many ideas about the focus question, but at this point, it isn't important to spend a lot of time on it. The important thing to find out is whether and how students might be thinking about molecules.*	Water changes from one state to another because of temperature. Heating causes evaporation, and cooling causes condensation. And then when liquid water cools a lot, the water freezes and changes to a solid (ice). The parts of solid water (ice) are bigger than the parts of liquid water, and the parts of liquid water are bigger than the parts of water vapor. [*Misconception*] Water vapor is thinner than liquid water.	Say more about that. Can you say more about what you mean by "parts"?

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				[*Misconception*] Maybe water-vapor molecules are smaller.	What do you mean by “thinner”? Tell me what you know about water molecules.
10 min	**Setup for Activity** **Synopsis:** The teacher introduces basic ideas about water molecules and sets up an activity adding a drop of food coloring to a cup of water to answer the question, *Do water molecules move?* **Main science idea(s):** • All states of water—solid, liquid, and gas—are made up of water molecules. These water molecules are so tiny that we can’t see individual molecules. We can see water molecules only when many of them are clustered together to form a drop of water or a piece of ice.	Make explicit links between science ideas and activities **before** the activity.	Before we can really start thinking about why water can exist as a liquid, a solid (ice), and a gas (water vapor), we need more information about water. **Show slide 5.** Water in all its states is made up of molecules. **NOTE TO TEACHER:** *If you have the Walter Wick book* A Drop of Water*, read the section on page 7 (“Water’s Smallest Parts”) to the class.* The smallest drop you see on this pinhead is made up of more than 300 trillion water molecules. That’s 300 followed by 12 zeros! The only way we can see water molecules is if large numbers of them are clustered together. **NOTE TO TEACHER:** • *Write 300,000,000,000,000 on the board.* • *Show students a straight pin to emphasize how small the water droplets in the photo are.*		

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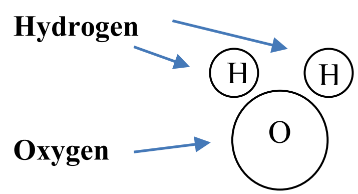
			Amazingly, scientists know about molecules even though they can’t see them under a microscope. They have a lot of evidence to support the idea that water is made up of molecules. Water molecules have a special shape and composition that make them water. Have you ever heard of H_20? **Show slide 6.** We call water H_2O because every single water molecule is made up of exactly two parts (or atoms) of hydrogen and one part (or atom) of oxygen. Its special shape looks like Mickey Mouse ears.  **NOTE TO TEACHER ON MISCONCEPTIONS:** *Pictures of water molecules might lead to a common misconception that water “contains” water molecules but isn’t completely made up of water molecules.* **ELL support:** You may want to consider color-coding different parts of the water molecules.		

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		Select content representations and models matched to the learning goal and engage students in their use. Ask questions to elicit student ideas and predictions.	**Show slide 7.** I'm going to draw a circle on the board to represent a water droplet, and I'd also like you to draw one in your science notebooks. How would you represent that this droplet of water is made up of water molecules? **Student drawing time.** **NOTE TO TEACHER:** *Students should draw many water molecules in their diagrams. This will get them thinking that water is* ***completely made up of molecules****, not just that it "contains" a few molecules.* **Show slide 8.** Now that we know what water molecules are, do you think they move? Let's see if we can find any evidence of moving water molecules. I'm going to place a cup of water in front of each group. It's **very important** that no one touch or jiggle the cup. We want to try to keep the water perfectly still. Then I'll add a drop of food coloring to each cup. **Show slide 9.** What do you think will happen to the food coloring in the water and why? **Turn and Talk:** Talk with an elbow partner	I'd draw water molecules inside the water droplet. Molecules are really much too small to see.	What are the limitations of this drawing?

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			about your predictions and reasoning. **Whole-class discussion:** What do you predict?	I think the food coloring will go down to the bottom of the cup. Because of gravity, and because I've seen something like this before.	Will it go straight down? Why do you think that? Will it stay at the bottom of the cup? Can you think of a reason why it wouldn't just stay at the bottom of the cup? What have you seen before that makes you think this?
10 min	**Activity** **Synopsis:** Students work in groups to observe the movement of food coloring in a cup of water, draw observations, and discuss in small	Make explicit links between science ideas and activities **during** the activity.	**Show slide 10.** In your science notebooks, draw a picture of what your cup looks like when the food coloring is first added, and then draw another picture as you observe something new happening. Think about how you might explain your observations.		

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	groups their ideas about what is making the food coloring move in different directions.	Engage students in analyzing and interpreting data and observations. Ask questions to challenge student thinking.	**NOTE TO TEACHER:** *Students should draw what happens at two points in time: immediately after the drop of food coloring is added to the water and again at a later point in time.* ***While groups are observing their cups of water,*** *ask them to describe their observations. Be sure they notice that the drop of food coloring doesn't go straight to the bottom of the cup. Sometimes the dye moves upward in a swirling motion.* **CONTENT NOTE TO TEACHER**: *Gravity does play a role in pulling the food-coloring molecules downward. But it doesn't explain why the food coloring moves sideways and upward.*	The food coloring doesn't just go to the bottom. It spreads all through the cup of water. Maybe gravity makes it move down. Maybe the molecules are	*Questions to ask each group:* Does the food coloring go straight down to the bottom of the cup? How might you explain your observations? What is making the food coloring move? What makes it move upward?

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				moving. [*It's unusual for students to come up with this idea on their own.*]	
6 min	**Follow-Up to Activity** **Synopsis:** The teacher helps students interpret the food-coloring experiment as evidence that water molecules in the liquid state move. **Main science idea(s):** • We have evidence from our food-coloring experiment that water molecules move in the liquid state.	Make explicit links between science ideas and activities **after** the activity. Ask questions to elicit student ideas and predictions.	**Show slide 11.** **Whole-class discussion:** What did you observe during the food-coloring experiment? **ELL support:** You may want to consider allowing ELLs to describe their observations using their drawings. I heard some of you saying that gravity was pulling the food coloring down. But what do you think is making the food coloring move upward and sideways? What might be causing the food coloring to move? **NOTE TO TEACHER:** *If students don't come up with the idea that water molecules are moving the food coloring, suggest it by asking this question: Do you think the movement of water molecules could partially explain our observations of the food coloring moving in the water?*	The food coloring swirled all around. It went down because of the force of gravity. It also moved up. Another kind of force? Vibrations from the table? Maybe the water is moving around even if we can't see it. Maybe the water molecules are moving? Water molecules	Say more about "all around." Can you say more about how the food coloring moved? What might make the food coloring move up? What might make the water molecules move?

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			Let's think about how moving water molecules might explain our observations. Look at your drawings of molecules that make up a drop of water. Now imagine that those water molecules are moving around all the time and bumping into each other. **Show slide 12.** In what direction would the water molecules have to move to push the food coloring up, down, sideways, and all over the cup? **Turn and Talk:** Talk about this question with a partner and be prepared to share your ideas with the class. **Whole-class discussion:** What ideas did you come up with that might explain how the water molecules would have to move to push the food coloring up, down, and sideways?	might move when the water is stirred or poured. Maybe the water molecules that we can't see were moving, and they pushed the food coloring in different directions. I think the water molecules would have to be moving in all directions—up, down, and sideways—because how else would the food coloring get pushed up and down	But did we stir or pour the water?

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			So our observations suggest that even though the cup of liquid water looks very still, the tiny molecules of water are always moving, and this movement pushes the food coloring around.	and sideways. But maybe water molecules don't have to move downward because gravity is going to pull the food coloring down.	
7 min	**Synthesize/Summarize Today's Lesson** **Synopsis:** Students review the focus question and write two new ideas about water in the liquid state. **Main science idea(s):** • Water is made up of tiny molecules. A water molecule is the tiniest part of water that is still water. • We have evidence from our food-coloring experiment that water molecules move around and slide past	Highlight key science ideas and focus question throughout. Engage students in making connections by synthesizing and summarizing key science ideas.	**Show slide 13.** So let's look again at our focus question: *Why is water sometimes a liquid, sometimes a solid, and sometimes a gas?* We have more to explore before we can answer this question. But what have we learned so far about water in the liquid state? **Show slide 14.** In your science notebooks, write two new ideas about water in the liquid state. Make sure to use the word *molecules*!		

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	one another in the liquid state.				
2 min	**Link to Next Lesson** **Synopsis:** The teacher links science ideas to the next lesson.	Summarize key science ideas. Link science ideas to other science ideas.	**Show slide 15.** So now we know that water is made up of tiny pieces called *molecules.* In the liquid state, these molecules are always moving around and sliding past one another. **Show slide 16.** To answer our focus question, we need to find out more about water molecules in the solid and gaseous states. Do they move just like water molecules in the liquid state? This is what we'll explore next time.		