The Water Cycle
Lesson 2a: From Gas to Liquid

Grade 5	**Length of lesson:** 55 minutes	**Placement of lesson in unit:** 2a 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:** Can you make water vapor in the air "reappear" as liquid water? Explain your thinking.
Main learning goal: Observations of the formation of liquid-water droplets on the outside of a cup of water with ice can provide evidence to support claims about whether water vapor in the air can "reappear" as liquid water.		
Science content storyline: We know that water can change from a liquid to a gas (water vapor) when heat is added. The water seems to disappear, but it's actually rising into the air as a gas called *water vapor*. Can gaseous water vapor reappear as liquid water? To answer this question, we observed liquid water appear on the outside of a cup of water with ice, but not on the outside of a cup of water at room temperature. We're working to explain where the liquid water came from. We considered different claims and the evidence that does or does not support them. Now we need some new science ideas to help with our reasoning.		
Ideal student response to the focus question: We observed liquid water form on the outside of a cup of water with ice, but not on the outside of a cup of room-temperature water. Where did that water on the cup of ice water come from? We decided against the claim that the water came from inside the cup, because the water in the cup is red, and the water on the outside of the cup is colorless. So our claim now is that the water on the cup came from the water vapor in the air, and the coldness of the cup has something to do with why it formed. Our evidence is that the liquid water is forming only on the cup of ice water, and most of the liquid water is forming at the top of the cup, where the ice is located. Now we need some more science ideas to improve our reasoning to support our claim.		

Preparation

Materials Needed	**Ahead of Time**

• Science notebooks
• Tray for each group, containing the following:
  • 1 clear plastic cup (or clear heavy-duty glass) labeled "Cup A." Cup A is filled with room-temperature water. A few drops of red food coloring are added, and the cup is covered with plastic wrap
  • 1 clear plastic cup (or clear heavy-duty glass) labeled "Cup B." Cup B is filled with water and ice. A few drops of red food coloring are added, and the cup is covered with plastic wrap.
  • Paper towels
  • 1–4 hand magnifying lenses
  • 1 flashlight
• Chart-paper diagram from the previous lesson (liquid →gas = evaporation) (**Save this for use again in lesson 3.)**
• *Optional:* chart paper, markers
	• Review the Water Cycle Content Background Document, especially sections 1.5, 1.6, 1.8, and 2.3.
	• Review the PowerPoint slides and modify them as you wish.
	• Decide which student-writing activities you may want to skip to save time. For example, do you want to remove the predictions in the activity setup or step 2 on slide 8, where students draw their observations?
	• At least one day before the lesson, set up the two-cups experiment and time how long it takes for condensation to occur. If it takes too long, you may need to add more ice to cup B and/or more humidity to the room by boiling a pot of water. This is critical! If there isn't enough humidity, there won't be enough water vapor in the air to condense on the side of cup B. If your area normally has low humidity at this time of year, you'll need to boil more water. In low-humidity environments, condensation may be less obvious, so you may need a hand magnifying lens to see it. Also be on the lookout for too much humidity in the room. In this case, moisture will form on the side of cup B right away and ruin the opportunity for students to make predictions.

Lesson 2a General Outline

Time	Phase of Lesson	How the Science Content Storyline Develops
5 min	**Unit central questions/link to previous lesson**: The teacher revisits the unit central questions and links to the previous lesson by posing a scenario for students to explain using ideas about evaporation.	• Water changes from a liquid to a gas (water vapor) when heat energy is added. This process is called *evaporation*. • As a result of evaporation, there is *water vapor* in the air all around us.
4 min	**Lesson focus question:** The teacher introduces the lesson focus question, *Can you make water vapor in the air "reappear" as liquid water? Explain your thinking.* Then the teacher elicits student ideas about the question.	
10 min	**Setup for activity:** The teacher elicits student predictions about what will happen to two cups of water containing red food coloring, one cup with ice and one at room temperature.	
15 min	**Activity:** Students observe two cups of water containing red food coloring (one cup with ice and one without) and discuss in small groups why they think water droplets are forming on the outside of the cup of ice water.	• Observations of the formation of liquid-water droplets on the outside of a cup of ice water provide evidence to support claims about whether water vapor in the air can "reappear" as liquid water.
10 min	**Follow-up to activity:** Students engage in a class discussion about their observations of the two cups and their ideas about how water formed on the outside of the cup of ice water.	
10 min	**Synthesize/summarize today's lesson:** Students return to the focus question and their observations of the water droplets forming on the outside of the cup of ice water. They write what they think is the strongest claim to explain this phenomenon and provide evidence to support the claim. The teacher summarizes progress so far in explaining this phenomenon.	
1 min	**Link to next lesson**: The teacher links science ideas to the next lesson.	

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5 min	**Unit Central Questions/ Link to Previous Lesson** **Synopsis:** The teacher revisits the unit central questions and links to the previous lesson by posing a scenario for students to explain using ideas about evaporation. **Main science idea(s)**: • Water changes from a liquid to a gas (water vapor) when heat energy is added. This process is called *evaporation*. • As a result of evaporation, there is water vapor in the air all around us.	Link science ideas to other science ideas. Highlight key	**Show slides 1 and 2.** Remember the big questions we're exploring in this unit on the water cycle: *How does water change in the world around us? Does Earth ever run out of water?* **Show slide 3.** Yesterday we found out one way water changes in our world. What kind of water change did we investigate? So does liquid water disappear during evaporation? **Show slide 4.**	Evaporation Evaporation is when liquid water changes state to a gas called *water vapor* and goes into the air. Heating causes water to evaporate. No. It goes into the air, but we can't see it.	How would you define *evaporation*? What did we find out anything the cause of evaporation? What do you mean by "it"?

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		science ideas and focus question throughout.	This is a very important idea to keep in mind. As a result of evaporation, liquid water changes to a gas called *water vapor.* Water vapor rises into the air, but we can't see it. So is there water vapor in the air in our classroom?	No, because we're not boiling water today. The water we boiled yesterday sent water vapor into the air, and that's probably still here.	Any other ideas?
			So there is water vapor in our classroom! **NOTE TO TEACHER**: *It's important to emphasize this point because students won't make sense of condensation if they don't understand that there is water vapor in the air.* **Show slide 5.**		
		Engage students in using and applying new science ideas in a variety of ways and contexts.	Let's see if we can use the science ideas we've been talking about to explain a situation where water changes from one form to another in our world. Use complete sentences and give as much detail as possible. **Scenario:** After it rains, the leaves on plants are wet. But after the Sun comes out, the leaves dry off. What happened to the water that was on the leaves?		

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			Turn and Talk (1 min): Talk with a partner about this scenario. **Whole-class discussion:** What happened to the water that was on the plant leaves?	The heat from the Sun made it evaporate. The liquid water.	What is "it"? How do scientists describe the process of evaporation?
				Evaporation is when liquid water changes into a gas called *water vapor*.	
				It goes into the air as a gas. We can't see it, but it's there.	Does the liquid water disappear? Where is it?
			Can you think of other situations where liquid water evaporates?	*Other examples of evaporation:* • Puddles drying up. • Wet clothes on a clothesline. • Water on a bathroom mirror. • Wet cars. • Hair drying.	
		Highlight key science ideas and focus	**Show slide 6.** In all of these situations, liquid water is changing from one form, or state, to		

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		question throughout.	another and rising into the air as water vapor that we can't see.		
4 min	**Lesson Focus Question** **Synopsis:** The teacher introduces the lesson focus question, *Can you make water vapor in the air "reappear" as liquid water? Explain your thinking.* Then the teacher elicits student ideas about the question.	Set the purpose with a <u>focus question</u> or goal statement.	**Show slide 7.** So we learned that water doesn't really disappear, but it can change from a liquid to a gas called *water vapor* that is in the air around us. We can't see it, but it's there. Today we're going to see if the opposite happens; that is, if water vapor in the air can reappear as liquid water. **NOTE TO TEACHER:** *Today's lesson focuses only on eliciting and probing student ideas. The scientific explanation will be given in lesson 2b.* The focus question we're going to investigate is *Can you make water vapor in the air "reappear" as liquid water? Explain your thinking.* Write this question in your science notebooks and draw a box around it. **NOTE TO TEACHER:** *Also post the focus question where students can see and refer to it throughout the lesson.* Does anyone have ideas about this? Have you ever seen liquid water appear without putting it there? When? **Turn and Talk (1 min):** Talk with a partner about these questions. Be prepared		

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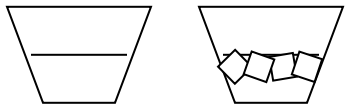
		Ask questions to elicit student ideas and predictions.	to share your ideas with the class. **Whole-class discussion:** Let's hear some of the examples you came up with. **NOTE TO TEACHER:** *Just elicit examples during the discussion. Don't spend a lot of time on getting students to elaborate their ideas. Ask probe questions only if a student's idea is confusing or unclear.* *If students have trouble coming up with ideas, ask,"Have you ever noticed that something outside is wet in the morning even though it didn't rain overnight?" This might help them think of examples*.	After it rains, everything is wet. In the mornings, the grass is wet. Sometimes the car is wet in the morning, but it didn't rain.	
10 min	**Setup for Activity** **Synopsis:** The teacher elicits student predictions about what will happen to two cups of water containing red food coloring, one cup with ice and one at room temperature.		**Show slide 8.** The activity we're going to do today will help us investigate our focus question. We're going to work in small groups to examine two cups of water: • Cup A is covered with plastic wrap and contains room-temperature water with red food coloring. • Cup B is also covered with plastic wrap but contains water and ice with red food coloring.  **Cup A** **Cup B**		

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			Turn and Talk: Now I want you to talk with a partner about what you think will happen if the cups sit for a while. Then draw and label the cups in your science notebooks and record (or talk about) your predictions. Be prepared to share your ideas with the class. 1. Draw and label "Cup A" and "Cup B." 2. Predict what you think will happen if the cups sit for a while and why. **Pairs work on drawings and predictions.**		
		Ask questions to elicit student ideas and predictions. Ask questions to probe student ideas and predictions. Make explicit links between science ideas and activities **before** the activity.	**NOTE TO TEACHER:** *As students work, walk around the room and listen to their ideas or read their notebook entries. Ask elicit and probe questions to clarify student thinking (e.g., "Tell me more about that."). But **do not** give hints or push students to come up with the "right" answer.* **ELL support:** Open-ended questions may be challenging for ELL students. For example, rather than asking students to tell you more about something, ask specific questions that will give some direction for students who seem lost.	*What you might hear as students are working:* The water in cup B will get lighter in color when the ice cubes melt. The water in cup A will start to evaporate because it's warmer than cup B. The ice cubes in cup B will melt, so the water level will go up.	*What you might say to students:* Tell me more about why you think that will happen. Nice link to our work with evaporation. That's a good connection to make. What do you think will make the ice cubes

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					melt?
				Cup B will get really cold and maybe get frost on it.	How do you think that can happen? Where do you think the frost will come from?
				We think water droplets will form on the inside of the plastic-wrap cover.	What makes you think that? Have you ever seen something like that happen?
			Whole-class discussion: Remember, we're trying to find out whether we can make water vapor from the air reappear as liquid water. Did writing down predictions and talking about them give you any new ideas?	Yes, [Julia] gave me the idea that the color of the water might change as the ice cubes melt	
			NOTE TO TEACHER: *As students share their ideas, ask probe questions to clarify, but don't spend a lot of time on this.* ***And don't ask them "why" challenge questions at this point.***	Because the ice cubes aren't colored.	Why do you think that*?*
			Write their ideas in shorthand on the board, overhead transparency, or chart paper. You can come back to these predictions later. Then give the following guidance.	[Hector] thinks water drops will form on the inside of the plastic cover because he's seen that happen in the refrigerator. But I disagree because we're not putting the cups in
			We have a variety of predictions about what might happen. Now let's look for evidence to confirm or challenge these		

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			predictions and see if we'll observe water droplets reappearing on cup B.	the refrigerator, right?	Good job! You've stated two different predictions and good reasons to support them.
15 min	**Activity** **Synopsis:** Students observe two cups of water containing red food coloring (one cup with ice and one without) and discuss in small groups their ideas about why they think water droplets are forming on the outside of the cup of ice water. **Main science idea(s):** • Observations of the formation of liquid-water droplets on the outside of a cup of ice water provide evidence to support claims about whether water vapor in the air can "reappear" as liquid water.	Engage students in analyzing and interpreting data and observations.	**ELL support:** Teachers may want to review the purpose, content, and expectations of this activity with ELLs ahead of time so they know what it's about, what they're supposed to do, and what the cups of water are supposed to represent. **Show slide 9.** **NOTE TO TEACHER:** *Pass out a tray of materials to each group: a cup of room-temperature water with red food coloring labeled "Cup A"; a cup of water with ice and red food coloring labeled "Cup B" (both cups are covered with plastic wrap); a flashlight; and hand magnifying lenses. Encourage students to use the flashlight and magnifying lenses to observe the cups more closely.* *Instruct students to follow the steps on the slide:* *1. Observe what is happening with the two cups using the flashlight and hand magnifying lens.* *2. Draw and label the two cups in their science notebooks to show their observations.* *3. Talk in their small groups about why they think the changes are*		

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		Ask questions to probe student ideas and predictions. Ask questions to challenge student thinking. Make explicit links between science ideas and activities **during** the activity.	*happening. (Students should make claims and give evidence.)* ***Option:*** *To save time, you can skip having students draw in their science notebooks.* ***Ensure that students in each small group are making the key observation that water droplets are forming on the cup of ice water****. Encourage them to think about this observation as they discuss why they think this is happening.* *Ask probe and challenge questions to get students talking about why they think water is forming on cup B. Examples:* • *What do you observe? How are you showing that in your drawing?* • *Where do you think that water on the outside of the cup is coming from?* • *Why did water form on the outside of the cold cup and not in other places?* • *Do you have any other ideas about where the water came from?* *As groups discuss what's happening, wander around the room and listen to students' ideas. What is visible about student thinking?* ***Don't push for the "right" answer at this point.*** *Instead,* ***listen carefully*** *to see if any of the students are thinking about water vapor in the air as the source of the water on cup B. (See the example for Group 5 in the Anticipated Student Responses column.)* ***Common misconceptions*** *among students*	*Ideas small groups might be discussing:* **Group 1:** There's water on the outside of cup B. It's clear and liquidy. The drops of water are near where the ice	*Sample questions to ask small groups:* How do you know it's water? Tell me more about where you saw water droplets.

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			are that the water is leaking through the cup (see Group 3 example in Anticipated Student Responses) or that water from inside the cup evaporated and then landed on the outside of the cup, like rain (see Group 4 example). *The red food coloring should challenge the leaking idea (although some students will argue that the water went through the cup but not the food coloring). The plastic wrap on top of the cup should challenge the idea that the water is coming from inside the cup through evaporation.*	cubes are. **Group 2:** Cup B has more moisture than cup A. The outside of the cup. Because of the ice. The ice made cup B have moisture on the outside. Maybe the cold water went out of the cup through tiny holes in the cup, and only cold water can get through the holes! [*Misconception*] I think the cold ice makes cup B sweat. [*Misconception*] **Group 3:** We think the water leaked through cup B to the outside.	It has more moisture where? Why do you think there is moisture on the outside of cup B but not cup A? Say that in a sentence. How do you think the ice did that? Do you have any ideas about why the drops are around where the ice is? What do you see that makes you think that?

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				[*Misconception*] I want to challenge the idea. The water on the outside of the cup is clear, and the water inside the cup is red. If it leaked through, the droplets on the outside should be red. I disagree because maybe the red stuff, the food coloring, can't get through the cup, but the clear water can get through. I don't think there are any holes in the cup, or else it wouldn't work very well for holding our drinks because it would always be leaking away.	Does anyone have any evidence to support or challenge the leaking idea? What can we do to test whether or not this is true? *[Wipe the cup and look for red food coloring.]* Good thinking. How could we test that idea? *[Put ice in a cup that contains **only** food coloring (no water). Or*

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					put a cup of food coloring in a cold place. See if clear moisture still forms on the cup.]
				Group 4: We think the water in the cup evaporated, went up into the air, and then fell down on the outside of the cup. Just like rain falls out of clouds. [*Misconception*]	Does anyone have evidence to support or challenge this idea?
				I have evidence to challenge this idea. The plastic cover would keep the water inside the cup. But maybe there are tiny holes in the plastic so that water vapor can get through but liquid water can't.	
				Group 5: Our idea is that it has something to do with the coldness.	Tell us more about what you think the cold has to do with water forming on the outside of the cup.
				Maybe the ice attracted	

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				the water in the air, like a magnet, and caused it to stick to the outside of the cup. Yes. My evidence is that the water droplets are forming only near where the ice cubes are. And they're forming on the *outside* of the glass, so they couldn't have come from the water inside the glass. So that's why I'm thinking they came from the water vapor in the air.	So you're talking about the water vapor that is in the air? Do you have any evidence to support your idea?
10 min	**Follow-Up to Activity** **Synopsis:** Students engage in a class discussion about their observations of the two cups and their ideas about how water formed on the outside of the cup of ice water. **Main science idea(s):** • Observations of the formation of liquid-water droplets on the outside of a cup of ice	Make explicit links between science ideas and activities **after** the activity. Engage students	**Show slide 10.** Now let's talk about what you observed. First, just share what you saw, not your reasoning. So what did you observe? Good, these are the observations we're	Water droplets formed on the outside of the cold cup. There were more drops right around where the ice was. The water drops were clear, not red.	

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	water provide evidence to support claims about whether water vapor in the air can "reappear" as liquid water.	in analyzing and interpreting data and observations. Engage students in constructing explanations and arguments. Ask questions to challenge student thinking.	trying to explain. So now we're going to build an explanation to answer the question, *How did the water droplets get on the outside of the cup of ice water?* As I went around the room, I heard different ideas about this. Let's hear some of your claims and the evidence you have to support (or challenge) them. Listen carefully because I'm going to ask you to consider all the different claims/ideas and then decide which claim and evidence you think are best in explaining how the water droplets got on the outside of the cup of ice water. So what are your claims and evidence? What are you thinking? **NOTE TO TEACHER**: *As students share their claims and evidence, encourage the class to ask questions, agree or disagree, and provide evidence to support or challenge each of the shared claims. Ask questions to challenge students to support or challenge ideas using evidence.*	The water leaked through the side of the cup. The liquid water evaporated and went out through the plastic wrap as water vapor into the air and then fell down like rain onto the outside of the cup. The ice was like a magnet that pulled water vapor in the air back into liquid water on the cup. *Ideal response:*	*For each claim, ask these questions:* • Does anyone have any evidence to support or challenge that claim? • Does anyone agree/disagree with that claim? Why?

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				The water vapor (gas) in the air turned to liquid water when it got near the ice.	
			IMPORTANT NOTE TO TEACHER: *If no one makes a claim about water vapor in the air being the source of the liquid drops on the cup, challenge students to think about the boiling-water experiment: "So let's be clear about the connection to what we know about evaporation. What happened to some of the liquid water when we boiled it?"*		
			As you think about the water vapor in the air, does that give you any new ideas about where the water on the outside of the cold cup came from?	It went in the air as water vapor. It evaporated. Maybe the ice is like the opposite of the boiling. Like the boiling made water vapor go into the air, and the ice made the water vapor turn back to liquid water.	
			Is the ice cooling anything besides the water inside the cup?	Yes, it's cooling the air around the cup. So that supports the idea that coldness is making	

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				water vapor in the air turn back to liquid water.	
10 min	**Synthesize/Summarize Today's Lesson** **Synopsis:** Students return to the focus question and their observations of water droplets forming on the outside of the cup of ice water. They write what they think is the strongest claim to explain this phenomenon and provide evidence to support the claim. The teacher summarizes progress so far in explaining this phenomenon. **Main science idea(s):** • Observations of the formation of liquid-water droplets on the outside of a cup of ice water provide evidence to support claims about whether water vapor in the air can "reappear" as liquid water.	Highlight key science ideas and focus question throughout. Engage students in constructing explanations and arguments.	**Show slide 11.** Let's return to our focus question again: *Can you make water vapor in the air "reappear" as liquid water? Explain your thinking.* Can we make water vapor reappear as liquid water? If so, how does it happen? If not, why not? To help us answer today's focus question, we're trying to explain our observations of water droplets forming on the outside of the cup of ice water. Now that you've had a chance to listen to different ideas that have been presented, I want you to think about another question: *How did the water droplets get on the outside of the cup of ice water?* **Individuals:** Write down in your science notebooks (underneath your drawings and observations of the two cups) what you now think is the best claim to answer this question. Then write down your evidence to support this claim. **Students write claims and evidence.** **NOTE TO TEACHER**: *Discussion of students' writing will occur at the beginning of lesson 2b.*		

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		Summarize key science ideas.	**Show slide 12.** Let's summarize where we are in exploring water changes. Last time, we learned about one way water can change states—from liquid to water vapor. Adding heat energy makes this process of evaporation happen. Now we're considering the opposite: *Can water vapor (gas) in the air turn back into liquid water?* Today we observed water droplets form on the outside of a cup of ice water. You've constructed your best claims about how that happened and recorded your evidence.		
1 min	**Link to Next Lesson** **Synopsis:** The teacher links science ideas to the next lesson.	Link science ideas to other science ideas.	**Show slide 13.** But to make a good scientific explanation, we also need to use science ideas and good logical reasoning. So next time we'll learn some new science ideas that will help us build a stronger explanation of why and how those water droplets formed on the outside of the cup of ice water.		