

Properties of Matter

Lesson 2b: Changing Matter by Adding and Removing Heat

Grade 2	Length of lesson: 40 minutes	Placement of lesson in unit: 2b of 5 two-part lessons on properties of matter, with two additional extension lessons
Unit central questions: What is matter made of? How can matter change?		Lesson focus question: What causes matter to change from a solid to a liquid or from a liquid to a solid?
Main learning goal: Solids can become liquids when heat is added. Liquids can become solids when heat is removed and the liquid matter cools.		
Science content storyline: Heating and cooling (removing heat) can cause changes in matter. Matter in its solid form can become a liquid when heat is added. This is called <i>melting</i> . Matter in its liquid form can become a solid when heat is removed and the liquid matter cools.		
Ideal student response to the focus question: Matter can change from a solid to a liquid when you add heat. Matter can change from a liquid to a solid when you take away heat and the matter cools.		

Preparation

<p>Materials Needed</p> <ul style="list-style-type: none"> • Science notebooks • Chart paper and markers • Class data table from lesson 2a (Heating and Cooling Matter) • Optional: Cardboard cutouts of the graphic of matter changing from a solid to a liquid and from a liquid to a solid <ul style="list-style-type: none"> • 1 circle or oval labeled “SOLID” (in caps) • 1 circle or oval labeled “LIQUID” (in caps) • 2 cardboard arrows—one labeled “Add Heat,” and the other labeled “Remove Heat” <p>Student Handouts</p> <ul style="list-style-type: none"> • 2.1 Card Sets (1 laminated set per pair) 	<p>Ahead of Time</p> <ul style="list-style-type: none"> • Review the content background document. • Cut apart and laminate the cards from handout 2.1 (Card Sets). Each pair of students should be given one set of laminated cards. For ease of distribution, place each set of cards in a sealable plastic bag. (Alternatively, you could have students work in teams of three for this activity.)
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Lesson 2b General Outline

Time	Phase of Lesson	How the Science Content Storyline Develops
4 min	Link to previous lesson: Students describe how matter (ice, chocolate, and crayons) changed from a solid to a liquid and back to a solid in the previous investigation when heat was added or taken away.	<ul style="list-style-type: none"> • Heating and cooling (removing heat) can cause changes in matter. When heat is added, matter can change from a solid to a liquid. When heat is removed, matter can change from a liquid to a solid.
1 min	Lesson focus question: The teacher reviews the focus question from the previous lesson: <i>What causes matter to change from a solid to a liquid or from a liquid to a solid?</i>	
5 min	Setup for activity: Using word cards, students work together to create two sentences that answer the focus question. One sentence describes what causes a solid to become a liquid, and the second sentence describes what causes a liquid to become a solid.	<ul style="list-style-type: none"> • Heating and cooling (removing heat) can cause changes in matter. When heat is added, matter can change from a solid to a liquid. When heat is removed, matter can change from a liquid to a solid.
10 min	Activity: Students create a graphic to illustrate the how heating and cooling (removing heat) can change matter from a solid to a liquid and from a liquid to a solid.	<ul style="list-style-type: none"> • Heating and cooling (removing heat) can cause changes in matter. When heat is added, matter can change from a solid to a liquid. When heat is removed, matter can change from a liquid to a solid. We can illustrate these science ideas by using a graphic organizer.
10 min	Follow-up to activity: Working with a partner, students use word and picture cards to create sentences showing how matter changes from a solid to a liquid or from a liquid to a solid when heat is added or removed.	<ul style="list-style-type: none"> • Many different kinds of matter can change from solids to liquids when heat is added. Liquids can become solids again when heat is removed and the matter cools. These changes are reversible, which means that matter can change back to the way it was before.
9 min	Synthesize/summarize today's lesson: Students share the sentences they created to show how matter can change when heat is added or removed.	<ul style="list-style-type: none"> • Heating can cause solid matter to become liquid matter. Removing heat can cause liquid matter to become solid matter. These changes are reversible, which means that matter can change back to the way it was before.
1 min	Link to next lesson: The teacher foreshadows the next lesson by asking students to consider how scientists would explain what happens when matter changes from a solid to a liquid and from a liquid to a solid.	

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			<p>How would you complete the next sentence on the slide?</p> <p><i>I think _____ caused the change in matter.</i></p> <p>That’s right! We learned that heat can cause matter to change from a solid to a liquid.</p> <p>Now I’d like you to complete the same sentences for each kind of matter, but this time describe what you saw after we took the matter off the griddle.</p> <p><i>The matter I saw started as _____ and changed to _____.</i></p> <p>NOTE TO TEACHER: <i>Students will likely point out that the water didn’t change back to ice when the heat was removed. You can deal with that anomaly in the next set of questions. For now, concentrate on the chocolate and the crayon wax.</i></p> <p>ELL support: Explain to ELL students why water is different from other liquids and what is required for water to change back to a solid.</p> <p>What do you think caused this liquid matter to change back to solid matter?</p>	<p>I think the griddle caused the change in matter.</p> <p>It added heat.</p> <p>The matter I saw started as melted chocolate and changed to hard chocolate.</p> <p>The matter I saw started as a liquid and changed to a solid.</p> <p>The matter cooled</p>	<p>How did the griddle cause the change in matter?</p> <p>Please use the words <i>solid</i> and <i>liquid</i> to complete the sentence.</p>

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			<p>Yes. When heat was taken away from the matter, it changed back to a solid, didn't it?</p> <p>Show slide 3.</p> <p>Would you say the changes in matter that we observed are reversible or not reversible? Explain why you think so.</p> <p>Let's talk about water for a moment. Do you think it might change back to ice if we removed enough heat?</p> <p>Today we'll continue exploring changes in matter that are reversible or make the matter change back to the way it was before.</p>	<p>down.</p> <p>You removed the heat.</p> <p>The changes are reversible because we saw them change back to the way they were before, except for the water.</p> <p>Yes. If we put the water in the freezer, it would change back to ice.</p>	<p>What is another way to say "cooled down" using our science ideas?</p>
1 min	<p>Lesson Focus Question</p> <p>Synopsis: The teacher</p>	Set the purpose	<p>Show slide 4.</p> <p>Turn in your science notebooks to the page where you</p>		

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	<p>reviews the focus question from the previous lesson: <i>What causes matter to change from a solid to a liquid or from a liquid to a solid?</i></p>	<p>with a <u>focus question</u> or goal statement.</p>	<p>wrote our last focus question, <i>What causes matter to change from a solid to a liquid or from a liquid to a solid?</i></p> <p>Draw a circle around this question as a reminder that this is our focus question for today, too.</p> <p>By the end of this lesson, you'll answer this question using everything you've learned about what causes matter to change.</p>		
5 min	<p>Setup for Activity</p> <p>Synopsis: Using word cards, students work together to create two sentences that answer the focus question. One sentence describes what causes a solid to become a liquid, and the second sentence describes what causes a liquid to become a solid.</p> <p>Main science idea(s):</p> <ul style="list-style-type: none"> • Heating and cooling (removing heat) can cause changes in matter. When heat is added, matter can change from a solid to a liquid. When heat is removed, matter can 	<p>Make explicit links between science ideas and activities before the activity.</p> <p>Select content representations and models matched to the learning goal and engage students in their use.</p> <p>Engage students in using and apply new science ideas in a variety of</p>	<p>Now let's find out what we already know about what causes matter to change from a solid to a liquid or from a liquid to a solid.</p> <p>NOTE TO TEACHER: <i>Use a few of the word cards from handout 2.1 (Card Sets) to help the class build two sentences about what causes matter to change. The purpose of this activity is to (1) prepare students for the main activity, (2) acquaint students with using the word cards and creating sentences so they'll feel more comfortable doing this on their own in the activity follow-up, and (3) provide another format for students to express their thinking about the key science ideas.</i></p> <p>Show slide 5.</p> <p>I have some word cards here that we'll use to create two sentences as a class that answer our focus question, <i>What causes matter to change from a solid to a liquid or from a liquid to a solid?</i> One sentence will describe what causes matter to change from a</p>		

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	change from a liquid to a solid.	ways and contexts.	<p>solid to a liquid, and the second sentence will describe what causes matter to change from a liquid to a solid.</p> <p>Let's look at the words on the slide that we can use to build our sentences:</p> <ul style="list-style-type: none"> • Solid • Liquid • Becomes • Changes • When heat is added • When heat is taken away <p>Take a moment to think about the different sentences we could build using these words.</p> <p>Student think time.</p> <p>Whole-class discussion: OK, how do you think we could arrange our word cards to create sentences that answer our focus question?</p>		
10 min	<p>Activity</p> <p>Synopsis: Students create a graphic to illustrate the how heating and cooling (removing heat) can change matter from a solid to a liquid and from a liquid to a solid.</p> <p>Main science idea(s):</p> <ul style="list-style-type: none"> • Heating and cooling 	<p>Make explicit links between science ideas and activities during the activity.</p> <p>Select content representations and models matched to the</p>	<p>Next, we'll try representing these science ideas in a different way. Open your science notebooks to the page where you wrote down today's focus question.</p> <p>Show slide 6 (circled words only).</p> <p>Under the focus question, write the words <i>liquid</i> and <i>solid</i> in big letters the way they're shown on this slide.</p> <p>NOTE TO TEACHER: <i>The PowerPoint slide is</i></p>		

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	<p>(removing heat) can cause changes in matter. When heat is added, matter can change from a solid to a liquid. When heat is removed, matter can change from a liquid to a solid. We can illustrate these science ideas by using a graphic organizer.</p>	<p>learning goal and engage students in their use.</p>	<p><i>animated so the arrows and words are added in sequence as students organize their ideas. If you create this graphic on a white board or chart paper, make sure to draw and write all of the elements in sequence.</i></p> <p><i>Alternatively, you could have students create the graphics using the cardboard cutouts (see optional supplies on overview page) and attach the circles and arrows to a bulletin board with Velcro or some other kind of fastener.</i></p> <p>ELL support: Consider having ELL students create their own graphics using the optional cardboard cutouts. This will give them an opportunity to participate more fully in the activity by handling and arranging the cards themselves.</p> <p>Based on what we saw in our investigation with the ice, the chocolate, and the crayon pieces, what causes a solid to become a liquid?</p>	<p>Heat.</p> <p>For matter to change from a solid to a liquid, we have to add heat.</p>	<p>Can you say that in a complete sentence?</p> <p>Does everyone agree that adding heat causes a solid to become a liquid? Does</p>

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			<p>How could we show what causes a <i>solid</i> to become a <i>liquid</i> using graphics like arrows.</p> <p>NOTE TO TEACHER: <i>Invite students to share their ideas. Then advance the PowerPoint animation to show an arrow pointing upward from the word SOLID to the word LIQUID. (Or draw an arrow if you created the graphic on chart paper instead of using the PowerPoint animation.) Have students draw the same graphic in their science notebooks.</i></p> <p>What do you think this arrow represents? What label or words should we add to the arrow?</p> <p>NOTE TO TEACHER: <i>Invite students to share their ideas. Then advance the PowerPoint animation until the words Add Heat show up next to the upward-pointing arrow (or write the label next to the arrow if you created the graphic on chart paper.)</i></p> <div data-bbox="814 1015 1234 1209" data-label="Diagram"> </div> <p>Show slide 7 (circled words, up arrow, and “Add Heat” label only).</p> <p>Now let’s think about what causes a <i>liquid</i> to become</p>	<p>The arrow represents changing from a solid to a liquid.</p> <p>We could write the words “Add Heat” next to the arrow.</p>	<p>anyone disagree?</p>

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			<p>a <i>solid</i>. How might we show this using an arrow? What label or words should we add to the arrow?</p> <p>NOTE TO TEACHER: <i>Elicit student ideas; then advance the PowerPoint animation to show an arrow pointing downward from the word LIQUID to the word SOLID. (Or draw the arrow if you created the graphic on chart paper.) Students may suggest using the words Cool Down as a label, but the phrase Remove Heat is more accurate. Advance the PowerPoint animation until these words appear next to the downward-pointing arrow (or write the label next to the arrow if you created the graphic on chart paper).</i></p> <div data-bbox="856 802 1444 993" data-label="Diagram"> </div> <p><i>Now is the time to emphasize that when scientists talk about heat, they only refer to more or less heat or adding and removing heat. At this point, 2nd graders don't need to grasp the concept that molecular motion (molecules moving faster or slower) relates to matter gaining or losing heat energy (not coldness). But using correct language at this grade level will help students understand these ideas when they're introduced in later grades.</i></p> <p>Does everyone agree that in order for matter to change from a liquid to a solid, we need to remove heat so the</p>		

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		Highlight key science ideas and focus question throughout.	<p>matter cools? Does anyone disagree?</p> <p>Show slide 8.</p> <p>So we've explored a few different ways to show how matter changes from a solid to a liquid and from a liquid to a solid. We've used data tables and created sentences. And now we've created a diagram or graphic with arrows and labels.</p> <p>We can use all of these resources to help us answer our focus question, <i>What causes matter to change from a solid to a liquid or from a liquid to a solid?</i></p>		
10 min	<p>Follow-Up to Activity</p> <p>Synopsis: Working with a partner, students use word and picture cards to create sentences showing how matter changes from a solid to a liquid or from a liquid to a solid when heat is added or removed.</p> <p>Main science idea(s):</p> <ul style="list-style-type: none"> Many different kinds of matter can change from solids to liquids when heat is added. Liquids can become 	<p>Make explicit links between science ideas and activities after the activity.</p> <p>Engage students in using and applying new science ideas in a variety of ways and contexts.</p>	<p>Now let's think about how different kinds of matter can change from solids to liquids and from liquids to solids.</p> <p>First, I'd like you to pair up with an elbow partner. Then I'll give you and your partner a set of cards. Some of the cards have pictures and words on them; other cards just have words on them.</p> <p>NOTE TO TEACHER: Give each pair of students a plastic bag containing one set of cards from handout 2.1.</p> <p>Show slide 9.</p> <p>For this activity, I want you to show what you know</p>		

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	<p>solids again when heat is removed and the matter cools. These changes are reversible, which means that matter can change back to the way it was before.</p>	<p>Highlight key science ideas and focus question throughout.</p>	<p>about matter. Use these cards to create sentences that answer our focus question, <i>What causes matter to change from a solid to a liquid or from a liquid to a solid?</i></p> <p>You don't have to use all of the cards to create your sentences, but make sure your sentences include the science ideas we've been learning about. If you need a word that isn't on any of the cards, you can write it on one of the blank cards. As you create your sentences, record them in your science notebooks. After the activity, you'll have an opportunity to share your sentences with the class.</p> <p>Any questions before we begin?</p> <p>NOTE TO TEACHER: Give pairs plenty of time to create as many sentences as they can with the cards. Circulate around the room as students work on their sentences and provide support as needed. Remind students to record their sentences in their science notebooks.</p>		
9 min	<p>Synthesize/Summarize Today's Lesson</p> <p>Synopsis: Students share the sentences they created to show how matter can change when heat is added or removed.</p> <p>Main science idea(s):</p> <ul style="list-style-type: none"> • Heating can cause 	<p>Engage students in making connections by synthesizing and summarizing key science ideas.</p>	<p>So who would like to share one of your sentences with the class?</p> <p>Let's show what we know about what causes matter to change from one form to another and help one another understand these ideas better.</p> <p>Show slide 10.</p> <p>Make sure to communicate like scientists as you share</p>		

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	<p>solid matter to become liquid matter. Removing heat can cause liquid matter to become solid matter. These changes are reversible, which means that matter can change back to the way it was before.</p>	<p>Engage students in communicating in scientific ways.</p>	<p>your ideas and give each other feedback.</p> <p>NOTE TO TEACHER: <i>Invite several pairs of students to share their sentences and pictures. Make sure their sentences describe matter changing from a solid to a liquid and from a liquid to a solid. As needed, help students reorganize their sentences to ensure scientific accuracy.</i></p> <p><i>During this share-out, record students' sentences on chart paper. Alternatively, you could record one sentence from each pair of students and help them revise it until it's scientifically accurate.</i></p> <p><i>Encourage students to communicate in scientific ways by listening to others' ideas, agreeing or disagreeing, asking clarifying questions, and adding their own ideas.</i></p> <p><i>Highlight sentences that accurately reflect key science ideas and answer the focus question in different ways. This will help reinforce the science ideas students have been learning about.</i></p> <p><i>Make sure students recognize that the changes in matter are reversible: A solid can change to a liquid when heat is added, and a liquid can change back to a solid if heat is removed. Remind students of their experiences with the ice, chocolate, and crayon pieces in the previous lesson. Or to help students focus on reversibility, you could highlight two sentences per pair showing matter changing from a solid to a liquid and then back to a solid.</i></p>		

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			<p><i>To give students more practice using graphics to illustrate the science ideas, you might have them use cardboard cutouts (see optional materials on overview page) to create graphics for each sentence they created. You can assess students' understandings of the science content by determining whether their sentences match their graphic organizers. Do they describe matter changing from a solid to a liquid or from a liquid to a solid? Is heat added or removed in this change?</i></p>		
1 min	<p>Link to Next Lesson</p> <p>Synopsis: The teacher foreshadows the next lesson by asking students to consider how scientists would explain what happens when matter changes from a solid to a liquid and from a liquid to a solid.</p>	Link science ideas to other science ideas.	<p>Show slide 11.</p> <p>In this lesson, we explored a different way to describe how matter changes from one form to another. Graphic organizers like the one we used today can help us explain these science ideas.</p> <p>How do you think scientists explain what happens when matter changes from a solid to a liquid or from a liquid to a solid?</p> <p>We'll find out next time!</p>		