Energy Transfer
Lesson 5a: Keeping Track of Energy

Grade 4	**Length of lesson:** 50 minutes	**Placement of lesson in unit:** 5a of 6 two-part lessons on energy transfer
Unit central question: How does the energy of an object move and change?		**Lesson focus questions:** Where does energy come from? Where does it go?
Main learning goal: Energy is never created or destroyed, but it can undergo many changes.		
Science content storyline: Energy moves from object to object and from place to place. We can detect energy in different ways. As energy moves and changes, it isn't destroyed or lost. It may be detected differently, but new energy isn't created. An energy-flow diagram can track the energy transfers and transformations that occur in interactions.		
Ideal student response to the focus questions: Energy moves from object to object, and it can change costumes or forms. For example, it can change from potential energy to kinetic energy. The ways we detect energy can change too. Sometimes we may detect energy as movement, and other times, we may detect it as sound or light. Sometimes it may seem like energy goes away or is destroyed, like when a light goes out, or you no longer hear a sound, or an object stops moving. But that doesn't mean energy went away. It just turned into other forms of energy that are difficult to detect. In the end, all useful energy turns into heat energy that spreads out all around us.		

Preparation

Materials Needed	Ahead of Time
• Student notebooks • Chart paper and markers • 3–4 hand-crank flashlights or flashlights that can be charged by shaking them (not flashlights with batteries) • Highlighters (for marking the handout) • Red pencils (1 per student) **Student Handouts** • 5.1 Mumford and Leroy's Big Crash, Part 4 (1 per student)	• Read the Energy and Energy Transfer Content Background Document: sections 6–10.

Lesson 5a General Outline

Time	Phase of Lesson	How the Science Content Storyline Develops
5 min	**Link to previous lesson:** The teacher reviews science ideas related to energy transfer and transformation.	• Energy moves from place to place or from object to object. We can detect energy in different ways. Energy doesn't disappear; it changes costumes by transforming into different forms.
1 min	**Lesson focus questions:** The teacher introduces the focus questions, *Where does energy come from? Where does it go?*	
8 min	**Setup for activity:** Students read part 4 of Mumford and Leroy's big crash and highlight all of the words and science ideas that relate to energy.	• As energy moves (transfers) and changes (transforms), it isn't destroyed or lost. It may be detected differently, but new energy isn't created.
12 min	**Activity:** The teacher demonstrates energy flow with a hand-crank flashlight. Then students use an energy-flow diagram to track and describe energy transformations in simple systems.	• As energy moves and changes, it isn't destroyed or lost. It may be detected differently, but new energy isn't created. An energy-flow diagram is a good way to track the energy transfers and transformations that occur in devices and in interactions between objects.
15 min	**Follow-up to activity:** Students use an energy-flow diagram to describe the energy transfers and transformations that take place in Mumford and Leroy's big crash.	
8 min	**Synthesize/summarize today's lesson:** Students describe how an energy-flow diagram can help them answer to the focus questions. Then they consider whether energy ever disappears and write down their ideas.	
1 min	**Link to next lesson:** The teacher announces that in the next lesson, students will use energy-flow diagrams to describe energy transfers and transformations in simple objects.	

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5 min	**Link to Previous Lesson** **Synopsis:** The teacher reviews science ideas related to energy transfer and transformation. **Main science idea(s):** • Energy moves from place to place or from object to object. We can detect energy in different ways. Energy doesn't disappear; it changes costumes by transforming into different forms.	Link science ideas to other science ideas. Summarize key science ideas.	**Show slides 1 and 2.** In our last lesson, we used diagrams to show how much potential and kinetic energy a marble had at the top of a hill and as it rolled down the hill. Let's think about our diagrams and how they relate to our story of Mumford and Leroy's big crash. Where did Mumford get his energy to ride down the hill? Where did Leroy get the energy to move after Mumford collided with him? So what happens with energy when two objects collide, whether it's Mumford and Leroy or two marbles? Who can state this as a science idea in a complete sentence?	His potential energy changed to kinetic energy. Some of Mumford's kinetic energy transferred to Leroy. When two objects collide,	How do you know this? What is your evidence? Can you give an example?

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			Another science idea we learned about is what happens when energy changes costumes. Can someone state this as a science idea in a complete sentence? **NOTE TO TEACHER:** *If these key science ideas aren't already displayed on the board or on chart paper, write them in a prominent place and have students record them in their notebooks as well.*	energy moves or transfers from one object to another object. Energy changes costumes when an object moves from a higher place to a lower place. Energy changing costumes means that it changes or transforms from one form of energy to another. Energy changed costumes or transformed when Mumford's potential energy at the top of the hill changed to	How do you know? What is your evidence? Can anyone add to this idea? Can you give an example from our story using science words?

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			That is a great review of our science ideas about energy! Keep these ideas and examples in mind throughout today's lesson.	kinetic energy as he rode down the hill.	
1 min	**Lesson Focus Questions** **Synopsis:** The teacher introduces the focus questions, *Where does energy come from? Where does it go?*	Set the purpose with a <u>focus question</u> or goal statement.	**Show slide 3.** For this lesson, we will think about two focus questions: *Where does energy come from? Where does it go?* Write these questions in your science notebooks and draw a box around them. We already have some ideas from our ramp-and-marble investigations and our story about Mumford and Leroy's crash that might help us answer these questions. Today we'll add to these ideas about how energy moves or transfers from object to object, and how it changes costumes or transforms into different kinds of energy.		
8 min	**Setup for Activity** **Synopsis:** Students read part 4 of Mumford and Leroy's big crash and highlight all of the words and science ideas that relate to energy. **Main science idea(s):**	Make explicit links between science ideas and activities **before** the activity.	**Show slide 4.** Next, we'll learn more about Mumford and Leroy's big crash. As you and a partner read through the handout, use a highlighter to highlight all the energy words and important science ideas about energy that you can find.		

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	• As energy moves (transfers) and changes (transforms), it isn't destroyed or lost. It may be detected differently, but new energy isn't created.		We'll review these words and ideas at the end of our investigation. **NOTE TO TEACHER:** *Distribute handout 5.1, (Mumford and Leroy's Big Crash, Part 4). Have students pair up and take turns reading a paragraph until they complete the essay. Alternatively, you can use a reading strategy that is common for your class.* *As students read the handout, circulate around the room and remind them to highlight all the words and important ideas that relate to energy. For example, they should highlight words like* kinetic energy *and* potential energy. *They might highlight statements like "Energy moved or transferred away from the collision," or "Some energy also transferred away from the crash as sound, light, and heat." Don't discuss the highlighted words at this point in the lesson. Students will use them in the follow-up.* **ELL support:** Rather than having students read the handout silently, read the essay aloud to the entire class or have English-language students read it so that ELL students can listen and follow along. **Individual reading time.** **Show slide 5.**		

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		Highlight key science ideas and focus question throughout.	The key science idea on the slide appears near the bottom of page 2 on the handout: *All of the energy in the crash came from somewhere and went somewhere.* Draw a box around this sentence on your handouts and then write it in your science notebooks. **NOTE TO TEACHER:** *Also write this sentence on chart paper so that students can refer to it throughout this lesson and future lessons.* Do you notice that this science idea relates to our focus questions, *Where does energy come from? Where does it go?* This is another important idea to keep in mind throughout this lesson.		
12 min	**Activity** **Synopsis:** The teacher demonstrates energy flow with a hand-crank flashlight. Then students use an energy-flow diagram to track and describe energy transformations in simple systems. **Main science idea(s):** • As energy moves and changes, it isn't	Select content representations and models matched to the learning goal and engage students in their use. Highlight key science ideas and focus question	**Show slide 6.** In today's investigation, we'll examine something you may or may not have seen before. We'll track energy changes using something called an *energy-flow diagram*. You'll need your science notebooks and a red pencil for this activity. **NOTE TO TEACHER:** *Please distribute a red pencil to each student if they do not have one.*		

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	destroyed or lost. It may be detected differently, but new energy isn't created. An energy-flow diagram is a good way to track the energy transfers and transformations that occur in devices and in interactions between objects.	throughout. Make explicit links between science ideas and activities **during** the activity.	Keep this key science idea in mind throughout the investigation: *All of the energy in an interaction between two objects comes from somewhere and goes somewhere.* **NOTE TO TEACHER:** *Show students a hand-crank flashlight or one that charges when you shake it. The cranking or shaking motion moves a magnet inside a coil of wire and creates an electric current that illuminates the lightbulb. It isn't necessary to explain this to students. Simply show them the flashlight without illuminating it yet.* **Show slide 7.** Have any of you ever seen a flashlight that operates without batteries? This flashlight turns on when you crank it by hand [*or shake it*]. On the slide is a box with a label that says "Hand-Crank Flashlight and Hand." Notice that instead of drawing a flashlight and a hand inside the box, I used these words as a label. In an energy-flow diagram, you do not need to spend time drawing all of the details. It is more important to show where the energy comes from and where it goes.		

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			NOTE TO TEACHER: *Using the diagram on the slide as a model (see sample below), draw the box on chart paper and have students copy it into their notebooks. Add the title at the top and the label inside the box, making sure to leave plenty of room around the box to add arrows and labels.* **Energy-Flow Diagram for Hand-Crank Flashlight**  Draw this box in your science notebooks and add the title at the top and the label inside the box. Make sure to leave plenty of room around the diagram to add other words and drawings. For this investigation, we'll be energy detectives again. When I start cranking the flashlight in a moment, my hand will be moving like this. **NOTE TO TEACHER:** *Demonstrate a cranking motion, but don't actually crank the flashlight yet.*	Yes, there's motion energy.	

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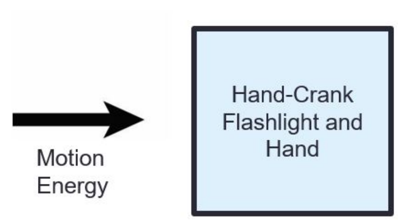
			Does anyone detect any energy when I do this? **Show slide 8.** So let's add motion energy to our diagrams. Using a red pencil, draw an arrow pointing toward the box and write the words *motion energy* underneath. **Energy-Flow Diagram for Hand-Crank Flashlight**  Now I'm going to start cranking the flashlight. When you detect any energy, raise your hand. Be energy detectives!	You used motion energy from your hand to make the flashlight work.	Say more about the motion energy.

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			NOTE TO TEACHER: *Crank the flashlight until it lights up. If you have extra hand-crank flashlights, pass them around the room and allow students to operate them. Make sure students can see them light up. The cranking motion should also make some noise and produce a little heat, but students won't be able to detect the heat.*		
			Show slide 9. What did you detect when I cranked the flashlight? What kind of energy did you detect? How did you detect it? How did the energy change costumes? So the motion energy you detected when I cranked the flashlight changed costumes and transformed into sound and light. **Show slide 10.** Let's add sound and light to our energy-flow diagrams. **Energy-Flow Diagram for Hand-Crank Flashlight**	I detected sound because I heard it. I detected light because I saw it.	

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		Engage students in making connections by synthesizing and summarizing key science ideas.	 So I used motion energy to crank the flashlight with my hand, and sound and light came from the flashlight. An energy-flow diagram makes it clear where the energy comes from (motion energy) and where it goes (sound and light). With the hand-crank flashlight, we detected energy in three different costumes: motion, sound, and light. Who has an idea about how to relate our science ideas about energy transfer and transformation to our energy-flow diagram? How would you describe our diagram using these ideas? **NOTE TO TEACHER:** *Help students use the science ideas of energy transfer and energy transformation in context throughout this discussion and in future lessons. These aren't intuitive concepts for 4th graders, but the energy-flow diagrams should help them make sense of the idea that energy isn't created or destroyed in interactions between objects; it transfers from object to object or*	I guess the motion energy from your hand transferred to the flashlight somehow. The motion energy you used to crank the	Does anyone agree or disagree? Can anyone add to these ideas?

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		Summarize key science ideas. Highlight key science ideas and focus question throughout.	*transforms from one form of energy to another. Mumford and Leroy's story can also help students contextualize these science ideas so they aren't so abstract.* **Show slide 11.** Let's summarize the key science ideas from our energy-flow diagram: • All of the energy in the flashlight came from somewhere and went somewhere. • We can use and energy-flow diagram to describe the energy transfers and transformations that happened with the flashlight. • Motion energy transferred from my hand to the flashlight. Then the motion energy changed costumes or transformed into sound energy and light energy.	flashlight turned into sound and light. The energy transforms from motion energy into sound energy and light energy.	Can you describe this using the science idea or word for energy changing costumes?
15 min	**Follow-Up to Activity**		**Show slide 12.**		

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	Synopsis: Students use an energy-flow diagram to describe the energy transfers and transformations that take place in Mumford and Leroy's big crash. **Main science idea(s):** • As energy moves and changes, it isn't destroyed or lost. It may be detected differently, but new energy isn't created. An energy-flow diagram is a good way to track the energy transfers and transformations that occur in devices and in interactions between objects.	Engage students in using and applying new science ideas in a variety of ways and contexts. Make explicit links between science ideas and activities **after** the activity. Highlight key science ideas and focus question throughout.	Now let's create an energy-flow diagram to describe what happened to the energy in Mumford and Leroy's big crash. **NOTE TO TEACHER:** *Have students locate handout 5.1 (Mumford and Leroy's Big Crash, Part 4).* Locate your handout from earlier and review the energy words and science ideas about energy you highlighted. Using these words and ideas, work with a partner to design an energy-flow diagram for the story about Mumford and Leroy's crash. As you work on your diagrams, keep our focus questions in mind: *Where does energy come from? Where does it go?* **NOTE TO TEACHER:** *Alternatively, you could divide the class into small groups for this activity.* *Circulate around the room as pairs [or small groups] work together on their diagrams. Students should all begin with Mumford's potential energy at the top of the hill and end with Leroy's kinetic energy at the bottom of the hill, as well as the sound, light, and heat that transferred away from the crash. Their energy-flow diagrams should look something like this:*		

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			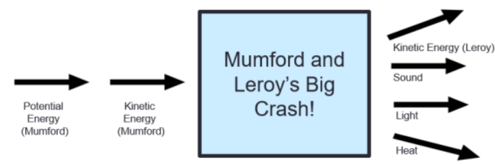 **Pairs work on energy-flow diagrams.** **Show slide 13.** **Whole-class share-out:** Let's share our energy-flow diagrams for Mumford and Leroy's crash. Describe where the energy came from and where it went. And make sure to include evidence of energy transfer and transformation from your diagram. As your classmates share their diagrams and explanations, think about these questions: • Where does the diagram show evidence of a *transfer* of energy? • Where does the diagram show evidence of energy *transformation* or energy changing costumes? • Does the diagram show that all of the energy came from somewhere and went somewhere?		

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		Engage students in communicating in scientific ways.	Communicate in scientific ways using sentence starters like the ones on the slide: • *I notice …* • *What do you mean when you say …?* • *I agree with _______ because …* • *I disagree with _______ because …* • *That idea makes sense to me because …* **NOTE TO TEACHER:** *Whenever possible, encourage students to use words, phrases, or sentences from the reading itself to add to or comment on another pair's energy-flow diagram.* **CONTENT NOTE TO TEACHER:** *In a pilot study of these lessons, students mistakenly thought that when an object stops, the kinetic energy (KE) reverts to potential energy (PE). They thought that a marble that continued to roll at the end of a ramp still had KE, but when it stopped, KE changed back to PE even if the marble was at the bottom of the ramp.* *If your students express this misconception, ask them whether the object is off the ground (above ground level) and remind them that for an object to have PE, the energy has to be stored somehow. Encourage students to examine the crash picture again (the last picture in handout 5.1) and notice the arrows that*		

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			represent how energy moves away from the crash. Then relate this to energy transfer when an object stops due to the force of friction. Your students may have already heard of friction and be familiar with the fact that friction produces heat—like skidding along a road would BURN. An object eventually stops, but the energy doesn't disappear. It transforms and moves away from the object as heat. **Show slide 14.** Now look at the energy-flow diagram on the slide. This diagram also shows where energy came from and where it went in Mumford and Leroy's big crash. Do your diagrams look something like this? Do you want to make any changes to your diagrams?		
8 min	**Synthesize/Summarize Today's Lesson** **Synopsis:** Students describe how an energy-flow diagram can help them answer the focus questions. Then they consider whether energy ever disappears and write down their ideas. **Main science idea(s):** • As energy moves and changes, it isn't destroyed or lost. It may	Highlight key science ideas and focus question throughout. Engage students in making connections by synthesizing and summarizing key science ideas.	**Show slide 15.** Today, we've been investigating these focus questions: *Where does energy come from? Where does it go?* In your science notebooks, explain how you think using an energy-flow diagram can help us answer these questions. Use the sentence starter on the slide: *An energy-flow diagram can help us understand where energy comes from and where it goes by __________________.*		

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	be detected differently, but new energy isn't created. An energy-flow diagram is a good way to track the energy transfers and transformations that occur in devices and in interactions between objects.	Ask questions to elicit student ideas and predictions.	In your answer, include an example of an energy-flow diagram that clearly shows where energy comes from and where it goes. Now think about the second question on the slide: *Does energy ever disappear?* Write your ideas about this in your science notebooks using the sentence starter on the slide: *I think energy [does/doesn't ever] disappear because* _____________. **NOTE TO TEACHER:** *Some students may still think that energy disappears when an interaction between objects ends. By answering this question, students will reveal their thinking, and you can address this misconception during the next lesson.* **Whole-class share-out:** Let's hear your ideas about whether energy disappears. How did you complete the sentence on the slide?		
1 min	**Link to Next Lesson** **Synopsis:** The teacher announces that in the next lesson, students will use energy-flow diagrams to describe energy transfers and transformations in	Link science ideas with other science ideas.	**Show slide 16.** Today we used energy-flow diagrams to track where energy comes from and where it goes in objects like a flashlight and in interactions like Mumford and Leroy's big crash. From these investigations, we gathered some		

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	simple objects.		important clues to help us answer our focus questions. In our next lesson, we'll create more energy-flow diagrams showing where energy comes from and where it goes in other kinds of objects.		