Energy Transfer
Lesson 5b: Energy-Flow Diagrams

Grade 4	**Length of lesson:** 55 minutes	**Placement of lesson in unit:** 5b 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 place to place or from object to object. 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. Ultimately, all energy transformations result in energy changing to heat, which either leaves Earth's system or is reflected back to Earth.		
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 time, 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 • Student notebooks • Chart paper and markers • 1 rubber band (for teacher) • 1 red pen or pencil (for each student) • Highlighters (for each student) • *For each team of 3 students:* • 1 bag of devices (e.g., windup toy, noisemaker, battery-operated device). All bags should contain similar items. **Student Handouts** • 5.2 Mumford and Leroy's Big Crash, Conclusion (1 per student)	**Ahead of Time** • Read the Energy and Energy Transfer Content Background Document: sections 6–10. • Prepare the bag of devices for each team. • **ELL support:** Identify Tier 2 and Tier 3 words in the lesson plan to review in advance with ELL students. Possible terms include *potential energy*, *kinetic energy*, *increase*, *decrease*, *energy transfer*, *transferred away*, *track energy*, *devices*, *stored energy*, and *crank*. A review of the analogy of energy changing costumes would also be useful.

Lesson 5b General Outline

Time	Phase of Lesson	How the Science Content Storyline Develops
5 min	**Link to previous lesson:** Students discuss their answers to the question posed in the previous lesson: *Does energy ever disappear?*	• As energy moves and changes, it isn’t destroyed or lost. Energy may be detected differently, but new energy isn’t created.
1 min	**Lesson focus questions:** The teacher reviews the focus questions, *Where does energy come from? Where does it go?*	
8 min	**Setup for activity:** The teacher introduces the science idea that potential energy is stored energy. The teacher also emphasizes that energy doesn’t disappear; rather, any useful energy ultimately transforms into heat energy that spreads throughout our surroundings. Then the teacher announces that in today’s activity, students will track energy in various objects.	• Potential energy is any kind of stored energy. A battery, a match, and any object that is stretched or compressed are all examples of objects with stored energy. • An energy-flow diagram is a good way to track the energy transfers and transformations that occur in devices and interactions between objects. Ultimately, any useful energy transforms into heat energy that spreads out all around us.
10 min	**Activity:** Students work in teams to examine a bag of common objects. Each student selects an object and draws an energy-flow diagram that shows the energy transfers and transformations related to that object.	• As energy moves and changes, it isn’t destroyed or lost. Energy 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 interactions between objects. Ultimately, any useful energy transforms into heat energy that spreads out all around us.
15 min	**Follow-up to activity:** Students share their energy-flow diagrams with their teammates and receive feedback. Then the teacher selects a few students to share their energy-flow diagrams with the class. During this discussion, the teacher emphasizes that energy is conserved.	• Energy is neither created nor destroyed; it transfers from place to place or from object to object. Energy also transforms or changes into different forms. Ultimately, any useful energy transforms into heat energy that leaves Earth’s system or is reflected back to Earth.
10 min	**Synthesize/summarize today’s lesson:** Students synthesize science ideas from today’s lesson by writing a paragraph about their energy-flow diagrams to answer the focus questions.	• Energy is neither created nor destroyed; it transfers from place to place or from object to object. Energy also transforms or changes into different forms. Ultimately, any useful energy transforms into heat energy that leaves Earth’s system or is reflected back to Earth.
5 min	**Link to next lesson:** Students read the conclusion about Mumford and Leroy’s big crash. Then the teacher asks students to consider how they might use science ideas about energy to help Mumford solve a problem.	

Time	Phase of Lesson and How the Science Content Storyline Develops	STeLLA Strategy	Teacher Talk and Questions	Anticipated Student Responses	Possible Probe/Challenge Questions
5 min	**Link to Previous Lesson** **Synopsis:** Students discuss their answers to the question posed in the previous lesson: *Does energy ever disappear?* **Main science idea(s):** • As energy moves and changes, it isn't destroyed or lost. Energy may be detected differently, but new energy isn't created.	Link science ideas to other science ideas. Engage students in constructing explanations and arguments. Engage students in communicating in scientific ways.	**Show slides 1 and 2.** At the end of our last lesson, I asked you to think about the question, "Does energy ever disappear?" and complete a sentence in your science notebooks. How did you complete this sentence? *I think energy [does/doesn't ever] disappear because __________.* Raise your hand if you think energy *does* or *can* ever disappear. Now raise your hand if you think energy *doesn't* ever disappear. Let's share our ideas about whether energy ever disappears. First, read the sentence you wrote in your science notebooks and then explain why you answered the way you did. Make sure to include evidence from our energy investigation. Be ready to agree, disagree, ask questions, and add ideas to the discussion. **NOTE TO TEACHER:** *At this point, don't correct students who think that energy does disappear. Simply listen to students' ideas and ask probe and challenge questions. Also encourage students who are on the right track to convince others using scientific explanations and arguments.*		

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		Ask questions to probe student ideas and predictions. Ask questions to challenge student thinking.	*As mentioned in the previous lesson, some students may cling to the idea that energy can be used up and disappear. (Also see the resource document, Common Student Ideas about Energy.) Through the use of energy-flow diagrams in this lesson and the previous lesson, help students understand that energy is never used up or destroyed. Instead, it can transfer from object to object or transform into different forms of energy. Emphasize that energy ultimately transforms into heat energy as part 4 of Mumford and Leroy's story demonstrated.*		
1 min	**Lesson Focus Questions** **Synopsis:** The teacher reviews 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.** Today we'll continue exploring the focus questions from our last lesson: *Where does energy come from? Where does it go?* You already have some ideas for answering these questions, but in this lesson, you'll gather more information about energy by creating new energy-flow diagrams for different objects. These diagrams will help us figure out if energy ever really disappears. By the end of the lesson, we should have enough information to answer our focus questions.		
8 min	**Setup for the Activity** **Synopsis:** The teacher		**Show slide 4.**		

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	introduces the science idea that potential energy is stored energy. The teacher also emphasizes that energy doesn't disappear; rather, any useful energy ultimately transforms into heat energy that spreads throughout our surroundings. Then the teacher announces that in today's activity, students will track energy in various objects. **Main science idea(s):** • Potential energy is any kind of stored energy. A battery, a match, and any object that is stretched or compressed are all examples of objects with stored energy. • An energy-flow diagram is a good way to track the energy transfers and transformations that occur in devices and interactions between objects. Ultimately, any useful energy transforms into heat energy that spreads out all around us.	Make explicit links between science ideas and activities **before** the activity.	In an earlier lesson, we learned about *potential energy*. What is potential energy? Can you use these words in a sentence and give us an example of something that has potential energy? **Show slide 5.**	Potential energy is an invisible form of energy, like an invisibility cloak. Potential means that an object isn't moving, but because gravity is pulling it, it *could* start moving. To have potential energy, an object has to be off the ground. A marble at the top of a ramp has potential energy. Mumford had potential energy because he was on top of a hill.	What else can you say about potential energy? Can you give us an example?

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		Link science ideas to other science ideas. Engage students in using and applying new science ideas in a variety of ways and contexts.	Before we begin today's investigation, you need to know something else about potential energy. Potential energy is another way of saying that energy is *stored*. Objects that are above ground level, like at the top of a hill or ramp, have stored energy. But other kinds of objects can have stored energy too. **Show slide 6.** Think about the battery on this slide. How do you know that it has stored energy? What if I stretch a rubber band? What can you say about its energy? What about the match I lit in the first	Because when you use something that has a battery, it does something. Like it turns on or moves or plays music. A rubber band has potential energy when you stretch it. If you let it go, the rubber band will move and have kinetic energy.	How does that relate to the battery's stored energy?

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			lesson? Do you think it had stored energy?	Yes.	What's your evidence?
				When you lit the match, it gave off light and heat.	
			What else has stored energy?	Food. Electricity. A bomb! Gasoline.	
			Can you use the word *potential* instead of *stored* to describe your ideas? Last time, we used an energy-flow diagram to track energy in a hand-crank flashlight. We also created a diagram showing the flow of energy in Mumford and Leroy's big crash. **Show slide 7.** Let's look again at a picture of the crash. Do you see how the arrows track where energy came from and where it went? Today, we'll track energy in some new objects, but before we begin, I want to point out an important idea about the energy in Mumford and Leroy's big crash		

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		Highlight key science ideas and focus question throughout.	that we haven't talked about yet. **Show slide 8.** Do you notice two arrows in the picture that show energy moving away from the crash as *heat*? This is an important science idea. **Show slide 9.** Earlier I asked whether energy ever disappears, and you shared some good ideas. The energy-flow diagrams you create in today's activity will show that energy is never used up or destroyed. It never disappears, but it does change into other forms of energy. In any interaction, some energy changes into heat energy, and all useful forms of energy eventually change into heat energy. Think about these science ideas as you work on your energy-flow diagrams. **NOTE TO TEACHER:** *After being told that energy never disappears, students might have the impression that energy, such as heat, light, sound, and motion, is somehow lurking around after something happens, waiting to reappear and be used again. In actuality, all energy transfers eventually result in energy changing to heat, which then either leaves Earth's system or is reflected back to Earth. This*		

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			heat energy is no longer useful for performing tasks or doing work, but it is an important part of energy conservation. *The activity in this lesson gives students an opportunity to think about the idea of energy converting into heat instead of simply disappearing or being used up. This is a challenging concept for students, but it's essential for understanding how energy behaves in the world around us.*		
10 min	**Activity** **Synopsis:** Students work in teams to examine a bag of common objects. Each student selects an object and draws an energy-flow diagram that shows the energy transfers and transformations related to that object. **Main science idea(s):** • As energy moves and changes, it isn't destroyed or lost. Energy 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	Engage students in using and applying new science ideas in a variety of ways and contexts.	**NOTE TO TEACHER:** *Show students the devices in one of the bags you assembled.* In this bag are some simple objects. During today's investigation, you'll work in teams of three using what you know about energy-flow diagrams to track where the energy comes from and where it goes in each of these objects. First, you'll split up into your teams and then we'll go over the directions for our investigation. **NOTE TO TEACHER:** *Divide the class into teams of three students, but don't distribute the bags of objects until after walking students through the activity instructions.* **Show slide 10.**		

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	interactions between objects. Ultimately, any useful energy transforms into heat energy that spreads out all around us.		In a moment, I'll give each team a bag of objects, and each of you will select one object from your team's bag. Your assignment as an energy detective will be to examine the object and identify at least two different forms of energy. Then you'll draw and label an energy-flow diagram for the object just like we did for the hand-crank flashlight. Use arrows to show where energy comes from and where it goes. Make sure to show where energy transfers from place to place. Also show where it transforms or changes costumes into another form of energy, such as motion or kinetic energy, sound, light, and heat energy. Your device may have potential energy, so be sure to label that, too. As you set up your energy-flow diagram, use the diagram we created for the hand-crank flashlight as a model. Like last time, don't spend time drawing pictures of your object. Simply use words to label it and then draw a box around it. The important part of this task is to track the energy in your device using an energy-flow diagram.		
		Highlight key science ideas and focus question	Throughout the investigation, keep our focus questions in mind: *Where does energy come from? Where does it go?*		

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		throughout. Ask questions to probe student ideas and predictions. Ask questions to challenge student thinking.	Any questions before we begin? **NOTE TO TEACHER:** *Distribute one bag of objects to each team and direct each student to select one object from the bag. Then direct them to examine the object and draw and label their energy-flow diagrams. The object each student selects is the system of interest in the interaction. If your students have learned about systems, feel free to use that terminology and describe the system in focus.* *As you circulate among the groups, ask questions to probe and challenge student thinking about the many energy transformations that are taking place related to the object. Students won't necessarily be able to identify all of the transformations. The main goal is for them to recognize that energy transformations are taking place, and that energy can be detected in many different ways. Encourage students to add heat to the output of each device as an example of where energy goes.*		
15 min	**Follow-Up to Activity** **Synopsis:** Students share their energy-flow diagrams with their teammates and receive feedback. Then the teacher selects a few		**Show slide 11.** Now that you've finished working on your energy-flow diagrams, I'd like you to share them with your teammates.		

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	students to share their energy-flow diagrams with the class. During this discussion, the teacher emphasizes that energy is conserved. **Main science idea(s):** • Energy is neither created nor destroyed; it transfers from place to place or from object to object. Energy also transforms or changes into different forms. Ultimately, any useful energy transforms into heat energy that leaves Earth's system or is reflected back to Earth.	Engage students in constructing explanations and arguments. Ask questions to probe student ideas and predictions. Ask questions to challenge student thinking. Engage students in	One at a time, demonstrate your device and talk through your energy-flow diagram, showing where the energy comes from and where it goes. Then ask your teammates how you might improve your diagram. Based on their input, make any revisions you think would make your diagram better or clearer. **NOTE TO TEACHER:** *As students share their energy-flow diagrams with their teammates, circulate from group to group and listen to students' descriptions. Ask questions to clarify or challenge student thinking.* *Ask a few students to share their diagrams with the class. Select diagrams that are thorough and illustrate interesting ideas about energy transfer and transformations that might promote further discussion.* **Show slide 12.** **Whole-class share-out:** I've asked a few students to share their devices and energy-flow diagrams with the class. As your classmates share, listen carefully and think about questions to ask or feedback to give. After everyone one has shared, we'll have a brief discussion about the diagrams. **NOTE TO TEACHER:** *If time allows, engage students in communicating in scientific ways to help them construct*		*Question to ask during class discussion:*

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		communicating in scientific ways.	*better explanations and arguments about where energy comes from and where it goes. Use this opportunity to reinforce the science idea that energy is neither created nor destroyed but is conserved. Emphasize that energy has to go somewhere, and eventually, it transforms into heat energy that spreads out all around us.*		• Did anyone detect different or additional kinds of energy?
10 min	**Synthesize/Summarize Today's Lesson** **Synopsis:** Students synthesize science ideas from today's lesson by writing a paragraph about their energy-flow diagrams to answer the focus questions. **Main science idea(s):** • Energy is neither created nor destroyed; it transfers from place to place or from object to object. Energy also transforms or changes into different forms. Ultimately, any useful energy transforms into heat energy that leaves Earth's system or is reflected back to Earth.	Engage students in making connections by synthesizing and summarizing key science ideas.	Today we used energy-flow diagrams to show that energy moves or transfers from place to place or object to object. It can also change costumes, or transform, into a different form of energy. **Show slide 13.** Let's revisit Mumford and Leroy's crash for a moment. When Mumford collided with Leroy, he was moving very fast, and Leroy wasn't moving at all. Who can describe the energy transfers that happened in Mumford and Leroy's crash?	Some of Mumford's motion energy was transferred to Leroy. I know this because Mumford stopped moving, and Leroy started moving.	What's your evidence?

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			Yes, Mumford slowed down and eventually stopped, and Leroy started moving. But Mumford didn't lose his energy when he stopped moving, and Leroy didn't create energy when he started moving. Mumford's energy was transferred to Leroy. We learned that energy can change costumes. What does that mean?	Changing costumes means that energy is still energy; it just looks different.	Can you name some of the different costumes energy wears?
		Summarize key science ideas.	**Show slide 14.** So energy can move or transfer from object to object, and it can change costumes or transform into different forms of energy. But energy can't be created or destroyed, and it never disappears. It may look, sound, or feel different when it changes forms, but it's still energy. When two objects collide or interact, we can detect these changes and represent them in an energy-flow diagram. Many of you have mentioned that Mumford and Leroy didn't keep moving—both of them eventually stopped. Even a		

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		Highlight key science ideas and focus question throughout	marble moving down a ramp eventually stops. Where do you think that energy goes? ***Embedded Assessment Task*** Does that question sound familiar? It's one of the focus questions we've been exploring. Who can tell me what the other question is? **Show slide 15.** I'd like you to answer these focus questions by writing a caption for the energy-flow diagram you created for your device. Your caption should be four or five sentences that describe the energy changes and transfers in your diagram. In other words, where did the energy come from, and where did it go in your object? Write your captions in your own words and make sure to include these science ideas in your descriptions: • Energy can move or transfer from object to object. • Energy can change costumes or transform into different forms of energy. • Energy isn't created or destroyed. It	Where does energy come from? *Ideal student response:* Energy can move from object to object, and it can change forms. For example, it can change from potential energy to kinetic energy. The ways we detect energy can change too. Sometimes we may detect it as movement, and other times, we may detect it as sound, light, or even heat.	

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			may look, sound, or feel different when it changes forms, but it's still energy. **NOTE TO TEACHER:** *Write these science ideas on chart paper and have students write them in their science notebooks as well. Also have students draw an arrow from their captions to their energy-flow diagrams to make sure they're clearly linked. If some students are struggling with their captions, consider allowing them to make an audio recording stating (1) how they know that energy isn't created or destroyed and (2) how they know where the energy goes.*	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 another form that's difficult to detect. Eventually, any useful energy turns into heat energy that spreads out all around us.	
5 min	**Link to Next Lesson** **Synopsis:** Students read the conclusion about Mumford and Leroy's big crash. Then the teacher asks students to consider how they might use science ideas about energy to help Mumford solve a problem.	Link science ideas to other science ideas.	**Show slide 16.** You've been great energy trackers today! Mumford heard you've been learning about energy, and he needs your help. Let's read about Mumford's problem in the conclusion of Mumford and Leroy's Big Crash.		

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			NOTE TO TEACHER: *Distribute handout 5.2 (Mumford and Leroy's Big Crash, Conclusion). Have students read the handout silently or aloud as a class.* **ELL support:** Instead of having students read the handout silently, read it aloud to the class or have a few students take turns reading so that ELL students can listen and follow along. Next time, you'll work in teams to create a device that will let the Thompsons know their paper has arrived. So do you think you can help Mumford solve his problem? Be ready to share your ideas next time! **NOTE TO TEACHER:** *If you want students to begin thinking about this challenge before the next lesson, distribute handout 6.1 (Guidelines for Mumford's Bell).*		