Energy Transfer
Lesson 2b: More or Less Motion Energy—How Do We Know?

Grade 4	**Length of lesson:** 35 minutes	**Placement of lesson in unit:** 2b of 6 two-part lessons on energy transfer
Unit central question: How does the energy of an object move and change?		**Lesson focus question:** What causes a moving object to have more or less motion energy?
Main learning goal: When an object moves faster, it has more energy.		
Science content storyline: Energy is all around us, and we can detect it with our senses. Objects in motion have energy. A marble rolls faster down a higher ramp than a lower ramp of the same length. When a faster-moving marble rolls down a higher ramp and collides with an object at the bottom, it will push that object farther than it would if it rolled down a lower ramp at a slower speed. Therefore, the faster-moving marble has more energy.		
Ideal student response to the focus questions: An object moves faster down a higher ramp than a lower ramp of the same length. When an object moves fast down a higher ramp and crashes into another object, it pushes the object farther than it does when it moves more slowly down a lower ramp. So when an object is moving fast, it has more energy than when it's moving more slowly.		

Preparation

Materials Needed • Science notebooks • Chart paper and markers • One ramp-and-marble setup (from lesson 2a) (to verify data as needed) **Student Handouts** • 2.1 Ramps, Speed, and Energy (students' completed work from lesson 2a and 1 blank copy for display)	**Ahead of Time** • Review the Energy and Energy Transfer Content Background Document: sections 1–4. • Prepare a blank copy of handout 2.1 (Ramps, Speed, and Energy) for display on a document reader, a Smart Board, or an overhead projector. During the class discussion, you'll record data from the previous investigation on the blank copy and answer question 3 (energy of the marble). • **ELL support:** Identify Tier 2 and Tier 3 words in the lesson plan to review in advance with ELL students, including *object(s)* and *motion energy*.

Lesson 2b General Outline

Time	Phase of Lesson	How the Science Content Storyline Develops
3 min	**Link to previous lesson:** Students review their predictions and discoveries as energy detectives from the previous lesson.	
2 min	**Lesson focus question:** The teacher reviews the focus question from the previous lesson: *What causes a moving object to have more or less motion energy?*	
5 min	**Setup for activity:** Students review the evidence they collected in the previous investigation about the motion energy of a marble rolling down two ramps of differing heights.	• We can compare the motion energy of an object (a marble) by measuring and comparing how far the object can move another object (a piece of Styrofoam) when the objects collide at the bottom of a ramp, and both the speed of the first object (marble) and the height of the ramp vary.
10 min	**Activity:** After analyzing their data and evidence, students conclude that the faster-moving marble has more motion energy because it pushed the Styrofoam farther. Then they use this information to answer the focus question.	• A marble will roll down a higher ramp faster than it will roll down a lower ramp of the same length. When a faster-moving marble rolls down a higher ramp and collides with an object at the bottom, it will push that object farther than it would if it rolled down a lower ramp at a slower speed. Therefore, the faster marble has more motion energy.
10 min	**Follow-up to activity:** Students use the CCCR strategy (consider, contribute, consult, revise) to refine their science ideas about motion energy. Then they revise their answers to the focus question.	
4 min	**Synthesize/summarize today's lesson:** The teacher summarizes key science ideas from the lesson.	• An object has more motion energy when it's moving fast than when it's moving more slowly.
1 min	**Link to next lesson:** The teacher announces that in the next lesson, students will read a story about two friends on bikes to further explore science ideas about the motion and energy of objects.	

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3 min	**Link to Previous Lesson** **Synopsis:** Students review their predictions and discoveries as energy detectives from the previous lesson.	Make explicit links between science ideas and activities. Ask questions to elicit student ideas and predictions.	**Show slide 1.** In our last lesson, we continued looking for clues, or evidence, of energy. As energy detectives, what kind of energy were you investigating? That's right. We investigated motion energy, or the energy of moving objects, by rolling a marble down two ramps of different heights. What did you observe? That's right! The marble rolled faster down the higher ramp than it did down the lower ramp. **Show slide 2.** Next, I asked the question, "Which marble has the most energy—the faster marble or the slower marble?" What did you predict? Raise your hand if you predicted that the *faster* marble has the most energy. Raise your hand if you predicted that the *slower* marble has the most energy.	Motion energy. One ramp was higher than the other, and the marble rolled faster down the higher ramp.	

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			NOTE TO TEACHER: *Most students will likely say that the faster marble has the most energy. You may want to ask students why they think the faster marble has more energy than the slower marble. They'll likely equate faster speed with greater energy but won't know exactly why this is the case.* Today, we'll think like scientists and analyze the data we recorded during our investigation to see if our predictions and ideas are correct.		
2 min	**Lesson Focus Question** **Synopsis:** The teacher reviews the focus question from the previous lesson: *What causes a moving object to have more or less motion energy?*	Set the purpose with a focus question or goal statement.	**Show slide 3.** Our focus question for this lesson is the same one we explored in the previous lesson: *What causes a moving object to have more or less motion energy?* At the end of the last lesson, you wrote an answer to this question in your science notebooks. Take a moment to find your answers. So how did you answer the focus question? Use the sentence starter on the slide to share your ideas: *I think a moving object has [more motion energy/less motion energy] when ____. My evidence is _____.*		

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			As energy detectives, you've been using your senses to detect the presence of energy in different objects. But today, you'll use data and evidence to support your ideas about the speed and energy of objects.		
5 min	**Setup for Activity** **Synopsis:** Students review the evidence they collected in the previous investigation about the motion energy of a marble rolling down two ramps of differing heights. **Main science idea(s):** • We can compare the motion energy of an object (a marble) by measuring and comparing how far the object can move another object (a piece of Styrofoam) when the objects collide at the bottom of a ramp, and both the speed of the first object (marble) and the height of the ramp vary.	Make explicit links between science ideas and activities **before** the activity.	**Show slide 4.** **NOTE TO TEACHER:** *Display a blank copy of handout 2.1 (Ramps, Speed, and Energy) on a document reader or projector.* Before we examine the data from our investigation, let's think about the type of evidence we collected. On your handouts, you recorded data for Ramp 1 and Ramp 2 showing these three things: 1. The speed of the marble 2. The distance the Styrofoam block moved 3. The height of the ramp In previous lessons, you detected the presence of energy using only your senses. But in this investigation, you used more than just your senses, didn't you? What else did you do?	We marked and measured things.	What did you mark?

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				We marked where the Styrofoam piece moved on our paper. We had to mark the distance the Styrofoam piece moved at least three different times and then record the middle measurement. We measured how high each ramp was.	How many times? Why do you think you needed at least three trials? What else did you measure?
			So we gathered evidence by measuring and recording data, not just by observing what happened. Our senses are important for detecting energy, but we also need data and evidence to help us determine which marble has more motion energy. **NOTE TO TEACHER:** *During this discussion, it's important for students to keep in mind that they used one marble for the ramp investigation rather than two. In the practice run, two marbles of the same size were used, one for each ramp. If you've been working on the idea of controlling variables in science investigations, point out that the size*		

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			variable (or the mass of an object) has been controlled in this investigation of motion energy. Next, we'll analyze and compare our data and evidence from the previous lesson to see if this information can help us answer our focus question.		
10 min	**Activity** **Synopsis:** After analyzing their data and evidence, students conclude that the faster-moving marble has more motion energy because it pushed the Styrofoam farther. Then they use this information to answer the focus question. **Main science idea(s):** • A marble will roll down a higher ramp faster than it will roll down a lower ramp of the same length. When a faster-moving marble rolls down a higher ramp and collides with an object at the bottom, it will push that object farther than it would if it rolled down a lower ramp at a	Engage students in analyzing and interpreting data and observations.	**Show slide 5.** **NOTE TO TEACHER:** *Have students locate their data from handout 2.1 (Ramps, Speed, and Energy). Continue displaying the blank copy of the handout on a document reader or projector and record student data during the discussion. Alternatively, you could record the handout data on the board or chart paper.* Find your handout from last time, and let's share the data and evidence we collected in our ramp investigation. As you share your data, I'll write it on this blank copy of the handout. What did you discover about the marbles and the ramps in our investigation? Which marble was on the higher ramp—the faster marble or the slower marble? Which marble was on the lower ramp?	The faster marble was on the higher ramp.	How do you know it was faster? Faster

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	slower speed. Therefore, the faster marble has more motion energy.				than what? What's your evidence?
				The slower marble was on the lower ramp.	How do you know it was slower? Slower than what?
			Which marble moved the Styrofoam farther?		
				The faster marble moved the Styrofoam farther.	What's your evidence?
				The slower marble moved the Styrofoam, but not as far as the fast marble did.	How much farther did the faster marble move the Styrofoam?
					Can anyone connect this to the speed and energy of the marbles?
			Which marble do you think has the most motion energy? Why?		
				The faster marble has more motion energy	
		Ask questions to probe student ideas and predictions.	**NOTE TO TEACHER:** *Ask probe and challenge questions until students reach the conclusion that the faster marble has more energy because it moved the block of Styrofoam a greater distance than the slower marble.*	than the slower marble.	How do you know? What's your evidence?
		Ask questions to		The data shows that the faster marble pushed the piece of Styrofoam	

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		challenge student thinking. Summarize key science ideas. Highlight key science ideas and focus question throughout.	**Show slide 6.** So based on our data and evidence, we can conclude that the faster marble has more motion energy than the slower marble. Let's state this as a science idea: *When an object moves faster, it has more motion energy.* **NOTE TO TEACHER:** *Write this key science idea on the board or on chart paper. Also have students copy it into their notebooks and draw a box around it. Then have them complete question 3 on their handouts, indicating the energy of the marble for each ramp (more or less).* Now go back and complete question 3 on your handouts based on the data and evidence we collected. Which marble has more energy, and which has less energy? **Show slide 7.** Let's revisit today's focus question, *What causes a moving object to have more or less motion energy?* Do you think we have enough evidence	farther than the slower marble, so the faster marble has more energy.	

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			to answer this question more completely and accurately now? First, review the answer you wrote in your science notebooks at the end of our last lesson. Then decide whether to change your answer by adding or deleting ideas or to start over and write a new answer. Make sure to use complete sentences and include evidence showing how the speed of a marble relates to the amount of motion energy it has. Work on your answers independently. That means no talking!	Yes! *Ideal student response:* • When an object is moving fast, it has more energy than when it's moving more slowly. An object will move faster down a higher ramp than a lower ramp that's the same length. My evidence is that the faster-moving marble on the higher ramp moved the block of Styrofoam farther than the slower-moving marble on the lower ramp.	
10 min	**Follow-Up to Activity** **Synopsis:** Students use the CCCR strategy (consider, contribute, consult, revise) to refine their science ideas about motion energy. Then they revise their	Engage students in making connections by synthesizing and summarizing key science ideas.	**Show slide 8.** Next, we'll use something called the *CCCR strategy* to refine our ideas about motion energy and improve our answers to the focus question. CCCR stands for *consider*, *contribute*, *consult*, and *revise*.		

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	answers to the focus question. **Main science idea(s):** • A marble will roll down a higher ramp faster than it will roll down a lower ramp of the same length. When a faster-moving marble rolls down a higher ramp and collides with an object at the bottom, it will push that object farther than it would if it rolled down a lower ramp at a slower speed. Therefore, the faster marble has more motion energy.		**NOTE TO TEACHER:** *Walk through the CCCR strategy with students—consider, contribute, consult, and revise. This strategy is similar to the Turn and Talk strategy. Students are encouraged to think for themselves, learn from their partners, and revise their own ideas based on* ***good*** *feedback and suggestions from their partners. Students' first attempts at using the CCCR strategy might be awkward, but with practice, it will become second nature to them and will greatly improve both their writing and their thinking about complex science ideas.* **Show slide 9.** For this activity, you'll work with a partner. First, you'll need to choose who will be the reader and who will be the listener. If you're the reader, you'll share the answer you wrote in your science notebook to the focus question. If you're the listener, think carefully about your partner's answer. Ask yourself, *Does the answer make sense? Do the ideas answer the focus question?* These are the *consider* and *contribute* steps of the CCCR strategy.		

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		Engage students in communicating in scientific ways.	Then switch roles. If you're the reader (or *contributor*) this time, share the answer you wrote in your notebook, and if you're the listener, think carefully about (or *consider*) whether the answer makes sense and whether the ideas answer the focus question. **Pairs work on consider and contribute steps.** **Show slide 10.** Next, decide who will be first to ask for feedback, and who will give feedback. This is the *consult* step of the CCCR strategy. If you're *requesting* feedback, ask your partner these questions: • Was anything confusing about my answer? • How can I make my answer clearer? • How can I make my answer more accurate? Don't change your answer yet. Just listen to your partner's suggestions for improving your answer. If you're the one *giving* feedback, use sentence starters like these:		

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		Engage students in constructing explanations and arguments.	• *I agree or disagree with your answer because _____.* • *I think if you said _____, it would make your answer clearer/more accurate.* Then switch roles and have the other partner give or receive feedback and suggestions for improving your answers. **Pairs work on the consult step.** **Show slide 11.** Now that both of you have given and received feedback, think about the suggestions and ideas for improving your answers. Will any of these suggestions improve your answer to the focus question? If so, you may want to add or delete ideas or completely rewrite your answers. This is the *revise* step of the CCCR strategy. This step gives you a chance to come up with the best, most complete answer to the focus question. Make sure to use a different-colored pen or pencil as you work on revising your answers. You'll work on this task independently. **Individuals work on the revise step.**		

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			Embedded Assessment Task **NOTE TO TEACHER:** *Consider using students' answers as an embedded assessment task to determine whether students have understood the science ideas in this lesson and made essential connections between them.*		
4 min	**Synthesize/Summarize Today's Lesson** **Synopsis:** The teacher summarizes key science ideas from the lesson. **Main science idea(s):** • An object has more motion energy when it's moving fast than when it's moving more slowly.	Summarize key science ideas.	**Show slide 12.** So far in this unit, we've explored some important science ideas about motion energy. Let's review them to summarize what we've learned. **NOTE TO TEACHER:** *During this discussion, write the following key science ideas on chart paper. This chart may be prepared ahead of time to save time. Also have students copy them into their science notebooks for future reference.* **Key science ideas:** • Energy is all around us, and we can detect it with our senses. • Moving objects have *motion energy*. • A marble will roll down a higher ramp faster than it will roll down a lower ramp of the same length. • When a faster-moving marble collides with an object, it will push the object farther than a slower-moving marble		

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			on a lower ramp would. • Therefore, a faster-moving object has *more* motion energy.		
1 min	**Link to Next Lesson** **Synopsis:** The teacher announces that in the next lesson, students will read a story about two friends on bikes to further explore science ideas about the motion and energy of objects.	Link science ideas to other science ideas. Engage students in using and applying new science ideas in a variety of ways and contexts.	**Show slide 13.** We've learned a lot about motion and energy from our ramp-and-marble investigation, haven't we? But marbles aren't the only objects with motion and energy. Have any of you ever ridden a bicycle down a hill? What about skateboarding down a ramp? **NOTE TO TEACHER:** *Most students should at least have experience with riding a bike down a hill.* Think about a time you rode a bicycle down a hill. What did it feel like? Did you have to pedal your bike to move down the hill? Describe your speed as you rode down the hill. What about your energy? **Show slide 14.**	I just coasted down the hill without pedaling. I went faster and faster down the hill until I reached the bottom. The faster I went, the more energy I had.	

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			In our next lesson, we'll read a story about two friends who are riding their bikes. One of the boys is riding very fast down a hill, and the other is waiting at the bottom. What do you think will happen next? What does this scenario have to do with motion and energy? Stay tuned to find out!		