Energy Transfer
Lesson 3a: Energy in a Crash

Grade 4	**Length of lesson:** 45 minutes	**Placement of lesson in unit:** 3a 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 happens to energy when objects collide?
Main learning goal: Energy can move or transfer from object to object.		
Science content storyline: Objects in motion have energy. When an object moves faster, it has more energy. Energy is transferred from one object to another during a collision. This results in a change of speed in both objects after the collision. These energy transfers can be illustrated in a diagram.		
Ideal student response to the focus question: When two objects collide, energy moves from one object to the other object.		

Preparation

Materials Needed
- Science notebooks
- Chart paper and markers
- *For each team of 3 students:*
  - Ruler (with a groove in the middle)
  - 2 marbles
  - Blocks of wood or notepads (to elevate the ramp)

Student Handouts
- 3.1 Mumford and Leroy's Big Crash, Part 1 (1 per student)
- 3.2 Mumford and Leroy's Big Crash, Part 2 (1 per student)

Ahead of Time
- Review sections 1–6 and read sections 7 and 8 in the Energy and Energy Transfer Content Background Document.
- **ELL support:** Identify Tier 2 and Tier 3 words in the lesson plan to review in advance with ELL students. Possible terms include *object(s)*, *collide*, *collision*, *transfer*, *transferred*, *motion energy*.

Lesson 3a General Outline

Time	Phase of Lesson	How the Science Content Storyline Develops
3 min	**Link to previous lesson:** Students share their answers to the focus question from the previous lesson: *What causes a moving object to have more or less motion energy?*	• Objects in motion have energy. A faster-moving object has more motion energy than a slower-moving object.
2 min	**Lesson focus question:** The teacher introduces the focus question, *What happens to energy when objects collide?*	
5 min	**Setup for activity:** Students read a story about two friends riding their bikes. One of the boys is riding very fast down a hill, and the other is waiting at the bottom. Students predict what will happen when the bikes collide.	• A faster-moving object has more motion energy than a slower-moving object. When a faster-moving object collides with a slower-moving object or an object that is stationary, the speed of both objects changes, and energy moves or transfers from the faster-moving object to the slower-moving or stationary object.
20 min	**Activity:** Students work in teams to design a method for testing their predictions. Then they use a model to investigate energy transfer during a collision.	
10 min	**Follow-up to activity:** Teams summarize the findings of their investigations and relate this to what happens to motion energy before and after a collision.	
4 min	**Synthesize/summarize today's lesson:** The teacher summarizes key science ideas from today's lesson.	• When two objects collide, energy moves or transfers from one object to the other object.
1 min	**Link to next lesson:** The teacher announces that in the next lesson, students will use science ideas from their ramp-and-marble investigation to answer the focus question, *What happens to energy when objects collide?*	

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3 min	**Link to Previous Lesson** **Synopsis:** Students share their answers to the focus question from the previous lesson: *What causes a moving object to have more or less motion energy?* **Main science idea(s):** • Objects in motion have energy. A faster-moving object has more motion energy than a slower-moving object.	Highlight key science ideas and focus question throughout.	**Show slides 1 and 2.** Last time, we used the CCCR strategy to refine our science ideas and revise our answers to an important focus question: *What causes a moving object to have more or less motion energy?* Let's share some of our ideas about motion energy. What does the speed of an object have to do with energy? So the speed of an object matters. But how do you know that a faster-moving object has more energy? What's your evidence? Right! The faster marble in our investigation moved the Styrofoam a greater distance. So we know that a faster-moving object has more motion energy than a slower-moving object. Make sure to keep this important science	*Ideal student response:* Objects in motion have energy. When an object moves 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 of the same length. In our investigation last time, the faster marble moved the Styrofoam farther than the slower marble did, so the faster marble had more energy.	

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		Link science ideas to other science ideas.	idea in mind throughout today's lesson.		
2 min	**Lesson Focus Question** **Synopsis:** The teacher introduces the focus question, *What happens to energy when objects collide?*	Set the purpose with a <u>focus question</u> or goal statement. Ask questions to elicit student ideas and predictions.	**Show slide 3.** Our focus question for this lesson is *What happens to energy when objects collide?* Write this question in your science notebooks and draw a box around it. **NOTE TO TEACHER:** *Write the focus question on the board for students to refer to throughout the lesson.* What do you think happens to energy when objects collide? What ideas do you have?	The energy might just stop. Because the energy runs out. The energy might go someplace else. In a car crash, the cars get all crumpled up, so maybe the energy makes things crumple.	Why do you think that? Where do you think the energy goes?
5 min	**Setup for Activity** **Synopsis:** Students read a	Make explicit	**Show slide 4.** At the end of the last lesson, I mentioned		

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	story about two friends riding their bikes. One of the boys is riding very fast down a hill, and the other is waiting at the bottom. Students predict what will happen when the bikes collide. **Main science idea(s):** • A faster-moving object has more motion energy than a slower-moving object. When a faster-moving object collides with a slower-moving object or an object that is stationary, the speed of both objects changes, and energy moves or transfers from the faster-moving object to the slower-moving or stationary object.	links between science ideas and activity **before** the activity. Ask questions to elicit student ideas and predictions.	a story about two friends on their bikes. Let's read this story and find out what happens. These friends will show up again in future lessons. **NOTE TO TEACHER:** *Distribute handout 3.1 (Mumford and Leroy's Big Crash, Part 1). Have students read the story silently or take turns reading it aloud as a class.* **ELL support:** To prepare ELL students to participate meaningfully in the activity, you may want to preview and read aloud parts 1 and 2 of this story to the entire class so that ELL students can listen and follow along silently. Alternatively, have several English-speaking students read the story aloud and have ELL students follow along silently. **Show slide 5.** So what do you predict will happen when Mumford and Leroy collide on their bikes? What will happen to Mumford's speed? What about Leroy's speed? What do you think will happen to their motion energy?		

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			Show slide 6. Write your predictions in your science notebooks using the sentence starters on the slide. Make sure to use complete sentences, and be prepared to share your ideas with the class. **ELL support:** To help ELL students process and understand the story before asking them to make predictions, consider having ELL students engage in a Think-Pair-Share. This will better equip them to participate meaningfully in the predictions. **Students work on their predictions.** **Whole-class share-out:** Let's hear your predictions. What do you think will happen when Mumford and Leroy collide? What did you predict about the *speed* of Mumford and Leroy after the crash? What did you predict about their *motion energy*?	Their speeds will change. The energy will stop	Can you say more about their speeds? How will their speeds change? Can you relate this to energy?

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			NOTE TO TEACHER: *Expect a variety of answers to these questions. Some students may focus on the crash and damage to the bikes; others will focus on whether Leroy and Mumford will be hurt.*	when they crash into each other.	What do you mean by "stop"?
20 min	**Activity** **Synopsis:** Students work in teams to design a method for testing their predictions. Then they use a model to investigate energy transfer during a collision. **Main science idea(s):** • A faster-moving object has more motion energy than a slower-moving object. When a faster-moving object collides with a slower-moving object or an object that is stationary, the speed of both objects changes, and energy moves or transfers from the faster-moving object to the slower-moving or stationary object.	Make explicit links between science ideas and activities **during** the activity. Select content representations and models matched to the learning goal and engage students in their use.	**Show slide 7.** For today's investigation, you'll work in teams of three using the same materials you used in previous lessons. You'll have a ruler with a groove for a ramp, two marbles, and blocks of wood [*or notepads*] to raise up your ramp. But this time, the ramp you set up will have only one height. Let's think about how we might use these materials to set up a model that represents the characters and events in our story. Scientists call this a *model* because it's *like* something in real life, but not exactly like it. Models help us imagine and think about real-life situations. What could the marbles represent in our model? Where would you place each marble in	One marble could represent Mumford, and the other could represent Leroy.	

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			the model?	The marble representing Mumford would go at the top of the ramp, and the marble representing Leroy would go at the bottom.	
			Show slide 8. Now let's think about how this model might help us predict what will happen when Mumford and Leroy collide on their bikes. What makes this a good model? In what ways do you think it's *like* Mumford and Leroy on their bikes?	The two marbles are like Mumford and Leroy. The marble representing Mumford will roll down the ramp and hit the other marble representing Leroy, just like Mumford riding his bike down the hill and crashing into Leroy. So in that way, it's a good model.	
			What makes this not such a good model? In what ways do you think it's *not like* Mumford and Leroy on their bikes?	For one thing, we don't know how steep the hill was where the boys were riding their bikes, so the model might not be that much like the real thing.	

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					Why is that important? What difference would the steepness of the hill make?
				Another problem with the model is that if the first marble hits the second marble, the second marble will roll, but I don't think Leroy will roll like a marble when Mumford crashes into him. He'll probably fall over, and maybe his bike will get dented. The model wouldn't show any of that happening.	
					Why is that important? What difference do you think that will make in what we see in our simulation?
				If the objects that are colliding can roll, it makes a big difference in how far they'll move after the collision.	
			NOTE TO TEACHER: *Divide the class into teams of three students and number the teams. Then distribute the materials each team will need for the investigation. Explain that for this*		

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			investigation, teams will design a plan to test their predictions about what will happen when Mumford and Leroy collide. **Show slide 9.** For this investigation, each team will design a way to test your predictions about what will happen when Mumford and Leroy collide. Talk with your teammates about how to model this scenario using a ruler and marbles. Work together to design a plan and then write it in your science notebooks. Your plan should include details about how you'll set up your model so the marbles will collide, and how you'll describe the speed and motion energy of each marble before and after the collision. In your descriptions, use words like *fast/faster*, *slow/slower*, *speed*, and *movement* or *motion energy*. **NOTE TO TEACHER:** *The idea is to have students set up a scenario where one marble rolls down the ramp and collides with a second marble. During the investigation, students should observe that the first marble picks up speed as it rolls down the ramp, and when it collides with the second marble,*		

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			it slows down and stops. The marble at the bottom of the ramp is stationary at the beginning and then starts moving once the marbles collide. This will be easier to see if teams build lower ramps. **Show slide 10.** Each of you will also need to set up a data table in your science notebooks for recording your data and observations. Your table should look similar to the one on this slide. Make sure to include columns to record data both *before* and *after* the collision and rows for recording marble speed and motion energy. Remember, you need to record data for *both* marbles. When your team has finished designing your plan and creating your data tables, I'll review and approve them. Then you can begin testing your predictions. First, you'll need to set up your ramp using the blocks of wood [*or notepads*] to raise it to the height you've decided on. Any questions? **Teams design their plans and conduct their investigations.** **ELL support:** Consider allowing ELL students to work in shared-language groups to develop and test their plans.		

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<tr><td></td><td></td><td></td><td>You may also want to have them draw (and label) their plans.

NOTE TO TEACHER: Circulate among the teams as they work on their plans. As they complete their plans and data tables, review and approve them. Each plan should include a detailed description of how the model will be set up and how the predictions will be tested. Data tables should be set up so that teams can record the speed and motion energy of each marble before and after the collision.

Display a sample data table for students to use as a model. The table might look something like this:

<table>
<tr><th></th><th colspan="2">Before Collision</th><th colspan="2">After Collision</th></tr>
<tr><td></td><td>Marble 1</td><td>Marble 2</td><td>Marble 1</td><td>Marble 2</td></tr>
<tr><td>Speed</td><td>Fast</td><td>None</td><td>Slower, then none</td><td>Slow Skid Slide</td></tr>
<tr><td>Motion Energy</td><td>A lot</td><td>None</td><td>Less, then none</td><td>Some</td></tr>
</table>

Allow adequate time for teams to implement their plans, test their predictions, and record their results and observations on their data tables. As you move from group to group during the activity, focus students' attention on what is happening with the marbles. Ask</td><td></td><td></td></tr>
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			students to describe the speed and motion energy of each marble before and after the collision.		
10 min	**Follow-Up to Activity** **Synopsis:** Teams summarize the findings of their investigations and relate this to what happens to motion energy before and after a collision. **Main science idea(s):** • A faster-moving object has more motion energy than a slower-moving object. When a faster-moving object collides with a slower-moving object or an object that is stationary, the speed of both objects changes, and energy moves or transfers from the faster-moving object to the slower-moving or stationary object.	Engage students in analyzing and interpreting data and observations.	**Show slide 11.** **Whole-class discussion:** What happened when you tested your predictions? Let's have Team 1 share their results and observations first. **NOTE TO TEACHER:** *Draw a data table on chart paper so you can record team results and observations during this discussion. Ask one team at a time to share what they discovered when they tested their predictions. Encourage students to describe the speed and motion energy of the marbles.* What happened with the marbles? How would you describe the *speed* of the two marbles *before* and *after* the collision?	The first marble rolled down the ramp and hit the second marble. The first marble rolled fast down the ramp, and	Can you show the class what you observed? Where was the marble going the fastest? Where was it going the slowest?

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				then it slowed down when it crashed into the marble at the bottom. The marble at the bottom wasn't moving before the collision, but when the first marble crashed into it, it started moving. The speed of the marble at the top was fast as it rolled down the ramp. The marble at the bottom had no speed at first, and then it gained speed after the first marble hit it.	Talk more about the speed of each marble.
		Link science ideas to other science ideas. Engage students in communicating in scientific ways.	What does marble speed have to do with motion energy? **NOTE TO TEACHER:** *After each team shares, invite other teams to agree, disagree, add on, ask questions, or report different results. If students report that both objects stopped after the collision, or that the marble rolling down the ramp maintained the same speed*	If a marble is moving at a faster speed, it has more motion energy. If it's moving at a slower speed, it has less motion energy.	

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			after the collision, challenge them to demonstrate the phenomena. *All teams should come up with similar results and observations:* • *Before the collision, Marble 1 is at the top of the ramp, and Marble 2 is at the bottom.* • *As Marble 1 rolls down the ramp, it picks up speed. At the bottom of the ramp, Marble 2 is stationary.* • *Marble 1 is moving fast when it collides with Marble 2 at the bottom of the ramp.* • *After the collision, Marble 1 slows down and then stops (or immediately stops), and Marble 2 starts to move.* • *Marble 2 slows down and eventually stops.* **Show slide 12.** How would you describe the motion energy of each marble before and after the collision? Make sure to use the words *motion energy* instead of *speed* in your answers.	The marble at the top of the ramp had a lot of motion energy as it was rolling down the ramp. After the collision, it lost its motion energy.	What's your evidence? What do you mean by "lost its motion

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			Show slide 13. Our ramp-and-marble models helped us test our predictions about what might happen when Mumford crashes into Leroy. Now let's read the rest of the story and find out what *really* happened. **NOTE TO TEACHER:** *Distribute handout 3.2 (Mumford and Leroy's Big Crash, Part 2) and have students read the story silently or read it aloud as a class.*	The marble at the bottom of the ramp had no motion energy at first, but after the collision, it gained motion energy.	energy"? What about the second marble's motion energy?
4 min	**Synthesize/Summarize Today's Lesson** **Synopsis:** The teacher summarizes key science ideas from today's lesson. **Main science idea(s):** • When two objects collide, energy moves or transfers from one	Engage students in making connections by synthesizing and summarizing key science ideas.	**Show slide 14.** **Whole-class discussion:** So were your predications about Mumford and Leroy's collision correct? Did your test results match what actually happened in the story? How was your model *like* what happened to Mumford and Leroy in the story?	The marble rolling down the ramp had motion	

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	object to the other object.			energy like Mumford did riding his bike down the hill. And like Leroy sitting on his bike at the bottom of the hill, the marble sitting still at the bottom of the ramp didn't have any motion energy. After the collision, the first marble had less motion energy like Mumford when his bike hit Leroy's bike. And the marble at the bottom of the ramp gained some motion energy like Leroy did when Mumford crashed into him.	
		Highlight key science ideas and focus question throughout.	**Show slide 15.** Let's review these important science ideas from part 2 of our story: • The faster an object moves, the more energy it has. • Energy can move or transfer somewhere else when objects collide. • When two objects collide, energy moves or transfers from one object to the other object.		

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			When Mumford and Leroy collided, some of Mumford's motion energy moved or transferred to Leroy.		
1 min	**Link to Next Lesson** **Synopsis:** The teacher announces that in the next lesson, students will use science ideas from their ramp-and-marble investigation to answer the focus question, *What happens to energy when objects collide?*	Highlight key science ideas and focus question throughout.	**Show slide 16.** In our next lesson, we'll use science ideas from our ramp-and-marble investigation to answer our focus question, *What happens to energy when objects collide?*		