

Forces

Lesson 4b: Friction

Grade 3	Length of lesson: 40 minutes	Placement of lesson in unit: 4b of 6 two-part lessons on forces
Unit central questions: What makes something start to move? What makes something stop moving or change direction?		Lesson focus question: What force makes a moving object slow down and eventually stop?
Main learning goal: When bumps on the surfaces of two objects push against one another, they create a force called <i>friction</i> . Friction is the reason moving objects on Earth slow down and eventually stop.		
Science content storyline: The toy car in our investigation traveled different distances over three different surfaces. Tiny bumps on these surfaces pushed against the bumps on the surface of the car’s wheels, creating a force called <i>friction</i> that acted in the opposite direction of the car’s motion. The pushing force of friction caused the car to slow down and eventually stop. In a world without friction, such as outer space, objects in motion would keep moving forever in a straight line.		
Ideal student response to the focus question: When bumps on the surfaces of two objects push against each other, it creates a force called <i>friction</i> that we can’t see. This force pushes in the opposite direction of an object’s motion and makes the object slow down and eventually stop.		

Preparation

<p>Materials Needed</p> <ul style="list-style-type: none"> • Science notebooks • Chart paper and markers • <i>Ramp setup from lesson 3b and 4a (for demonstration):</i> <ul style="list-style-type: none"> • Wood strip (for ramp) • 1–2 wood blocks to support the ramp • Toy car (from lesson 2b) • Hand strip (from lesson 4a) • 3 foam-board arrows of different lengths (from lesson 2a) <p>Student Handouts</p> <ul style="list-style-type: none"> • Optional: 2.1 What Are the Forces? (from lesson 2b) • 4.2 Friction (1 per student) 	<p>Ahead of Time</p> <ul style="list-style-type: none"> • Review section 3 (Friction) in the content background document. • Set up the ramp and hand strip for a class demonstration at the beginning of the lesson. • Optional: Prepare handout 2.1 (What Are the Forces?) for display on a document reader as needed during the review of key science ideas. • Decide whether you want students to read the essay on friction (handout 4.2) as a class, individually, or in pairs. You could read it aloud the first time as students follow along and then have students read the essay again silently. Alternatively, you could have students read the essay silently the first time and then pair up and take turns reading alternating paragraphs aloud. Choose the strategy you think will be most effective in helping your students comprehend the information. • ELL support: Before the lesson, read through handout 4.2 (Friction) with ELL students and answer any questions.
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Lesson 4b General Outline

Time	Phase of Lesson	How the Science Content Storyline Develops
8 min	Link to previous lesson: The teacher reviews key science ideas about forces. Then students discuss how they think the hand strip from the previous lesson exerts a force on the toy car.	<ul style="list-style-type: none"> • A <i>force</i> is a push or pull that causes a change in an object's motion. A force always involves an interaction between two objects. In most cases, two objects must touch to exert a force that causes motion. • <i>Gravity</i> is a force that pulls an object toward Earth without requiring it to touch the ground. • When the toy car rolls over the hand strip, tiny bumps on the surfaces of the two objects push against one another, creating a force that makes the car slow down and eventually stop.
1 min	Lesson focus question: The teacher reviews the focus question from the previous lesson: <i>What force makes a moving object slow down and eventually stop?</i>	
5 min	Setup for activity: The teacher introduces the word <i>friction</i> and adds the definition to the word wall.	
15 min	Activity: Students think about three guiding questions as they read a short essay about friction and underline sentences they think will help them answer the questions.	<ul style="list-style-type: none"> • When bumps on the surfaces of two objects push against one another, they create a force called <i>friction</i>. Friction is what causes moving objects to slow down and eventually stop.
5 min	Follow-up to activity: Students reread a key section in the essay and consider how tiny bumps on the surfaces of objects, such as the wheels of the toy car and the floor, create friction.	<ul style="list-style-type: none"> • When bumps on the surfaces of two objects push against one another, they create a force called <i>friction</i>. Friction is what causes moving objects to slow down and eventually stop. The bigger the bumps on a surface, the greater the force, or friction, pushing in the opposite direction of an object's motion.
5 min	Synthesize/summarize today's lesson: The teacher reviews the focus question and discusses the answer with students. Then students write a description of friction that they could present to another 3rd grader who hasn't studied forces yet.	
1 min	Link to next lesson: The teacher announces that in the next lesson, students will investigate what happens if more than one force acts on an object.	

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8 min	<p>Link to Previous Lesson</p> <p>Synopsis: The teacher reviews key science ideas about forces. Then students discuss how they think the hand strip from the previous lesson exerts a force on the toy car.</p> <p>Main science idea(s):</p> <ul style="list-style-type: none"> • A <i>force</i> is a push or pull that causes a change in an object’s motion. A force always involves an interaction between two objects. In most cases, two objects must touch to exert a force that causes motion. • <i>Gravity</i> is a force that pulls an object toward Earth without requiring it to touch the ground. • When the toy car rolls over the hand strip, tiny bumps on the surfaces of the two objects push against one another, creating a force that makes the car slow down and 	<p>Link science ideas to other science ideas.</p> <p>Highlight key science ideas and focus question throughout.</p>	<p>Show slides 1 and 2.</p> <p>Let’s look again at the hand strip from our last investigation and review what we know about forces.</p> <p>NOTE TO TEACHER: <i>Point to the word wall so students can follow along as you review key science ideas from the unit.</i></p> <p>First, we know that a <i>force</i> is a push or pull that causes a change in an object’s motion. A force always involves an interaction between two objects. In most cases, two objects must touch to exert a force that causes motion.</p> <p><i>Gravity</i> is a force that pulls an object toward Earth without requiring it to touch the ground.</p> <p>In our investigation of the three surfaces, gravity was the force that caused the car to start moving down the ramp.</p> <p>NOTE TO TEACHER: <i>Emphasize the key idea that gravity is the force that caused the toy car to start moving down the ramp.</i></p> <p>Show slide 3.</p>		

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	eventually stop.	Select content representations and models matched to the learning goal and engage students in their use.	<p>So let's think a bit more about how the hand strip relates to the science idea of forces. We know that the force of gravity pulled on the car and made it start to move.</p> <p>When the car rolled down the ramp and over the hand strip, what happened to the car's motion?</p> <p>NOTE TO TEACHER: <i>Use the ramp setup to demonstrate the car rolling down the ramp and over the hand strip.</i></p> <p>What do the hands on the hand strip represent?</p> <p>Do you think the hands have anything to do with making the car slow down and stop? Why or why not?</p> <p>In lesson 2, we used arrows to represent the strength and direction of a force. Do you think the hand strip is like the arrows?</p>	<p>The car slowed down and then stopped after it rolled over just a few of the hands.</p> <p>The hands look like they're pushing against the car.</p> <p>The hands represent a force that's pushing on the car.</p> <p>Yes! The hands make the car slow down by pushing against it.</p> <p>I guess so. Like the</p>	<p>What is that push called? Can you tell us what the hands represent using scientific words?</p>

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			<p>NOTE TO TEACHER: <i>Place the foam arrows where students can access them.</i></p> <p>Can someone use the foam arrows to show us the force of the hands pushing against the car?</p> <p>What is the direction of each arrow?</p> <p>NOTE TO TEACHER: <i>As needed, assist students with using the arrows to represent the force of gravity pulling the car down the ramp toward the ground, as well as the force of the hand strip pushing back on the car to slow it down.</i></p> <p>Remember the handout in lesson 2 that showed two hands pushing on the toy car?</p> <p>NOTE TO TEACHER: <i>It might be helpful to display handout 2.1 (What Are the Forces?) on a document reader</i></p>	<p>arrows, the hand strip shows the force pushing the car in the opposite direction.</p> <p>The opposite direction of the car's motion. The hand strip pushes back on the car.</p>	<p>The opposite direction of what?</p>

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			<p><i>during this review.</i></p> <p>In one picture, you drew arrows to represent what would happen if two people pushed the car with <i>equal</i> force, and in the other picture, you drew arrows to show what would happen if one person pushed the car with <i>more</i> force than the other.</p> <p>In today’s lesson, we’ll read an essay about why moving objects slow down and stop and what causes that to happen.</p> <p>As we explore some new ideas about forces, keep those hands from lesson 2 and the hand strip in mind!</p>		
1 min	<p>Lesson Focus Question</p> <p>Synopsis: The teacher reviews the focus question from the previous lesson: <i>What force makes a moving object slow down and eventually stop?</i></p>	Set the purpose with a <u>focus question</u> or goal statement.	<p>Show slide 4.</p> <p>Today we’ll continue exploring our focus question from last time: <i>What force makes a moving object slow down and eventually stop?</i></p> <p>In this lesson, we’ll find out what that force is called and learn more about what causes moving objects to slow down and stop.</p>		
5 min	<p>Setup for Activity</p> <p>Synopsis: The teacher introduces the word</p>	Make explicit links between	<p>Show slide 5.</p> <p>Scientists use a special word to describe</p>		

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	<p><i>friction</i> and adds the definition to the word wall.</p>	<p>science ideas and activities before the activity.</p> <p>Highlight key science ideas and focus question throughout.</p>	<p>what we observed when the toy car rolled over different surfaces. That word is <i>friction</i>.</p> <p><i>Friction</i> is a force that's created when bumps on the surfaces of two objects push against one another. Friction is what causes moving objects to slow down and eventually stop.</p> <p>This is an important science idea we can use to describe the force that pushes back on a moving object and makes it slow down and stop.</p> <p>Take a moment to copy this definition into your science notebooks.</p> <p>NOTE TO TEACHER: <i>Add this definition of friction to the word wall.</i></p>		
15 min	<p>Activity</p> <p>Synopsis: Students think about three guiding questions as they read a short essay about friction and underline sentences they think will help them answer the questions.</p> <p>Main science idea(s):</p> <ul style="list-style-type: none"> When bumps on the surfaces of two objects 	<p>Make explicit links between science ideas and activities during the activity.</p>	<p>Let's find out more about how and why the force of friction works.</p> <p>NOTE TO TEACHER: <i>Distribute handout 4.2 (Friction) and indicate how you want students to read the essay (as a class, independently, or in pairs). (See Ahead of Time on overview page.)</i></p> <p>ELL support: ELL students will be better equipped to understand the reading if you review it with them in</p>		

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	<p>push against one another, they create a force called <i>friction</i>. Friction is what causes moving objects to slow down and eventually stop.</p>		<p>advance and answer any questions.</p> <p>Show slide 5 (first question only).</p> <p>NOTE TO TEACHER: <i>Spend about 5 minutes on each of the following questions.</i></p> <p>As we read this essay on friction, think about the first question on the slide:</p> <ul style="list-style-type: none"> • What causes friction? <p>Underline a sentence or sentences in the reading that you think will help you answer this question.</p> <p>Show the second question on slide 5.</p> <p>Now read the page again with an elbow partner [<i>or individually</i>]. This time, think about the second question on the slide that relates to our investigation of the three surfaces:</p> <ul style="list-style-type: none"> • Why does friction exert a different amount of force on different surfaces? <p>Turn and Talk: Discuss with your partner how the examples in the reading are similar to or different from the</p>		

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			<p>surfaces in our investigation.</p> <p>Show the last question on slide 5.</p> <p>Now find the paragraph in the reading that might help you answer the third question on the slide.</p> <ul style="list-style-type: none"> • What would happen if there were no friction acting on an object? <p>Turn and Talk: Discuss this question with your partner and use evidence from the reading to support your ideas.</p>		
5 min	<p>Follow-Up to Activity</p> <p>Synopsis: Students reread a key section in the essay and consider how tiny bumps on the surfaces of objects, such as the wheels of the toy car and the floor, create friction.</p> <p>Main science idea(s):</p> <ul style="list-style-type: none"> • When bumps on the surfaces of two objects push against one another, they create a force called <i>friction</i>. Friction is what causes moving objects to slow 	<p>Make explicit links between science ideas and activities after the activity.</p>	<p>Let’s read a section in the essay one more time.</p> <p>NOTE TO TEACHER: <i>Have the class read in unison the text that begins with the sentence, “When you let go of the toy car, it starts to slow down,” and ends with the sentence, “That pushing force is the friction that makes a moving object slow down and eventually stop.” This is an important lead-in to the next lesson about multiple forces acting on an object and the “invisible” bumps on the surface of an object and the floor.</i></p> <p>Show slide 7.</p> <p>In our previous investigation, you used a</p>		

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	<p>down and eventually stop. The bigger the bumps on a surface, the greater the force, or friction, pushing in the opposite direction of an object's motion.</p>		<p>hand lens, or magnifying glass, to examine the three surfaces and the wheels of the toy car.</p> <p>Today's reading says, "If you look carefully with a magnifying glass, you'll see tiny bumps on the car's wheels and tiny bumps on the floor."</p> <p>Is that what you observed when you examined the three surfaces and the car wheels?</p> <p>Did you observe tiny bumps on the tires?</p> <p>What about the three surfaces?</p>	<p>I didn't see bumps on the tires exactly. I thought they looked more like grooves.</p> <p>They were rough, not smooth. More like the sandpaper.</p> <p>They all had bumps. But the tile had really tiny bumps.</p> <p>I didn't see any</p>	<p>Tell us more about the grooves. Were they rough or smooth?</p> <p>Does anyone disagree or have something to add?</p>

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			<p>Can we all agree that if we look very carefully, we can see tiny bumps or ridges on all of these surfaces, even on a tile surface that feels very smooth?</p> <p>Try to imagine that all of these tiny bumps push against one another when an object moves over a surface.</p> <p>In our next lesson, you'll have an opportunity to figure out and explain how this happens.</p>	<p>bumps on the carpet. It had strings. But the surface was very rough.</p>	
5 min	<p>Synthesize/Summarize Today's Lesson</p> <p>Synopsis: The teacher reviews the focus question and discusses the answer with students. Then students write a description of friction that they could present to another 3rd grader who hasn't studied forces yet.</p>	<p>Highlight key science ideas and focus question throughout.</p> <p>Engage students in making connections by synthesizing and summarizing key science</p>	<p>Show slide 8.</p> <p>Today, we continued investigating our focus question, <i>What force makes a moving object slow down and eventually stop?</i></p> <p>What did we discover? What force causes moving objects to slow down and stop?</p> <p>Yes, friction is the force that makes objects slow down and eventually stop. How does that happen?</p>	<p>Friction!</p> <p>Tiny bumps on the surfaces of two</p>	

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		ideas.	<p>So we know that friction is the answer to our focus question.</p> <p>But how would you describe this science idea to another 3rd grader who hasn't had this unit on forces yet?</p> <p>Think about this question; then write a description in your science notebooks that you could use to help a classmate understand what friction is. Try to include words from the list on the slide.</p> <p>You may also refer to the words and definitions on the word wall and in the handout, but don't copy them. Describe the science ideas about friction in your own words!</p> <p>ELL support: Give ELL students an opportunity to discuss their ideas with a shared-language partner before writing their descriptions.</p> <p>NOTE TO TEACHER: <i>If this activity is too difficult for your students to complete individually, you might engage the class in building a description together. Invite one student to begin a</i></p>	objects push against each other and create friction.	

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			<p><i>description of friction with a few words and then invite other students to add to or revise the science ideas so you end up with a complete scientific description of friction in the students' own words. (For a sample description, see "Ideal Student Response to the Focus Question" on the overview page.)</i></p>		
1 min	<p>Link to Next Lesson</p> <p>Synopsis: The teacher announces that in the next lesson, students will investigate what happens if more than one force acts on an object.</p>	<p>Summarize key science ideas.</p> <p>Link science ideas to other science ideas.</p>	<p>Show slide 9.</p> <p>Today, we learned an important word scientists use to describe a force that pushes against moving objects and makes them stop. That force is called <i>friction</i>.</p> <p>But what happens if <i>more than one</i> force pushes or pulls an object at the same time?</p> <p>We'll explore this question next time!</p>		