

Forces

Lesson 6b: Explaining Forces and Motion in Real-Life Scenarios

Grade 3	Length of lesson: 45 minutes	Placement of lesson in unit: 6b 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: How can ideas about forces help us explain the motion of objects?
Main learning goal: Ideas about forces can help us predict and explain the motion of objects.		
Science content storyline: A <i>force</i> is a push or pull that causes a change in motion and involves an interaction between two objects. A force can cause an object to start moving, slow down, speed up, change direction, or stop moving. <i>Friction</i> is a force that pushes in the opposite direction of an object's motion. Rougher (bumpier) surfaces generate more friction between objects. <i>Gravity</i> is a force that consistently pulls an object toward Earth. Each of these science ideas about forces can help us predict and explain motion in everyday situations.		
Ideal student response to the focus question: Forces are pushes or pulls that can change an object's motion. If I know the strength (size) and direction of the forces acting on an object, I can predict and explain whether or not it will move and in what direction.		

Preparation

Materials Needed

- Science notebooks
- Chart paper and markers
- *Props for team skits:*
 - 10-foot rope (for tug-of-war)
 - Shoes with a heavy tread and shoes with smooth (slick) soles
 - Piece of smooth (slick) plastic or tarp (for slip and slide)
 - 2 baseballs
 - 6 foam-board arrows (2 short, 2 medium, and 2 long)

Student Handouts

- 6.1 Scenario Cards (1 card/page per team)
- 6.2 Scenario Pictures (1 per student)

Ahead of Time

- Review the content background document, especially sections 4 (Net Forces) and 5 (Tracking Changes in Motion with Cartoons).
- Assemble props for the team skits (see Materials Needed).

Lesson 6b General Outline

Time	Phase of Lesson	How the Science Content Storyline Develops
4 min	Link to previous lesson: Students summarize their findings from the previous cotton-ball investigation. During this review, they describe the forces acting on the cotton ball and the resulting motion.	
1 min	Lesson focus question: The teacher introduces the focus question, <i>How can ideas about forces help us explain the motion of objects?</i> and asks students which word is different from the previous focus question.	
4 min	Setup for activity: The teacher explains that students will work in teams using key science ideas to describe the forces acting on objects in real-life scenarios and explain the resulting motion.	
10 min	Activity: Teams identify and illustrate the forces acting on the object(s) in their scenarios. Then they decide how to act out these forces using foam-board arrows and other props.	<ul style="list-style-type: none"> • A <i>force</i> is a push or pull that causes a change in motion and involves an interaction between two objects. A force can cause an object to start moving, speed up, slow down, change direction, or stop moving. <i>Friction</i> is a force that pushes in the opposite direction of an object's motion. Rougher (bumpier) surfaces generate more friction between objects. <i>Gravity</i> is a force that consistently pulls an object toward Earth. Each of these science ideas about forces can help us predict and explain motion in everyday situations.
15 min	Follow-up to activity: Teams present their skits to the class, demonstrating the forces acting on the object(s) in their scenarios and explaining why the object(s) moved or didn't move.	<ul style="list-style-type: none"> • <i>Forces</i> are pushes and pulls that change an object's motion. If we know the strength (size) and direction of the forces acting on an object, we can predict and explain whether or not it will move and in what direction.
10 min	Synthesize/summarize today's lesson: Students write their best answers to the unit central questions in their science notebooks and include specific examples from the lesson sequence to support their ideas.	<ul style="list-style-type: none"> • <i>Forces</i> are pushes or pulls that change an object's motion and involve an interaction between two objects. A force can cause an object to start moving, speed up, slow down, change direction, or stop moving. <i>Friction</i> is a force that pushes in the opposite direction of an object's motion. <i>Gravity</i> is a force that consistently pulls an object toward Earth. Each of these science ideas about forces can help us predict and explain motion in everyday situations.
1 min	Link to future lessons: The teacher links science ideas about forces and motion to future lessons.	

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4 min	<p>Link to Previous Lesson</p> <p>Synopsis: Students summarize their findings from the previous cotton-ball investigation. During this review, they describe the forces acting on the cotton ball and the resulting motion.</p>	Link science ideas to other science ideas.	<p>Show slides 1 and 2.</p> <p>In our last lesson, we tested your predictions about the motion of a cotton ball dropped in front of a rotating fan.</p> <p>Let’s quickly review the forces that acted on the cotton ball and what happened to the cotton ball’s motion.</p> <p>First, what force made the cotton ball start to move?</p> <p>What force caused the cotton ball to change direction?</p>	<p>Gravity made the cotton ball start moving when we dropped it.</p> <p>The fan moved the cotton ball through the air.</p> <p>The wind from the fan blew the cotton ball and made it change direction.</p> <p>The force was a push of air from the</p>	<p>Say more about how the force of gravity acted on the cotton ball.</p> <p>Did the fan cause the cotton ball to change direction? Please be more specific.</p> <p>So what force was involved?</p>

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			<p>What force caused the cotton ball to stop moving?</p> <p>You've become great force and motion detectives!</p> <p>In our final lesson on forces, you'll work in teams to apply what you know about force and motion to other real-life scenarios.</p> <p>You'll also get to show what you know as the Physics Players in a <i>Forces and Motion</i> skit!</p> <p>NOTE TO TEACHER: <i>Divide the class into teams of three or four students and have students gather in their assigned teams now.</i></p>	<p>fan on the cotton ball.</p> <p>Friction made the cotton ball stop moving.</p> <p>The bumps on the cotton ball and the bumps on the floor pushed against each other and made the cotton ball stop.</p>	<p>Tell us more about friction and how it stopped the cotton ball.</p> <p>Does anyone want to add to these ideas?</p>
1 min	<p>Lesson Focus Question</p> <p>Synopsis: The teacher</p>	Set the purpose	<p>Show slide 3.</p> <p>Our focus question today is <i>How can ideas about</i></p>		


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	introduces the focus question, <i>How can ideas about forces help us explain the motion of objects?</i> and asks students which word is different from the previous focus question.	with a <u>focus question</u> or goal statement.	<p><i>forces help us explain the motion of objects?</i></p> <p>This question is the same as our last focus question, except for one word. Which word is different?</p> <p>Yes. So instead of <i>predicting</i> the motion of objects in this lesson, you'll use ideas about forces to <i>explain</i> an object's motion.</p> <p>ELL support: Explain the differences between these two actions as explicitly as possible and consider adding them to a word wall as Tier 3 words.</p> <p>Write this new focus question in your science notebooks and draw a box around it.</p> <p>NOTE TO TEACHER: <i>Write the focus question on the board for students to refer to throughout the lesson.</i></p>	The word <i>explain</i> .	
4 min	<p>Setup for Activity</p> <p>Synopsis: The teacher explains that students will work in teams using key science ideas to describe the forces acting on objects in real-life scenarios and explain the resulting motion.</p>	Make explicit links between science ideas and activities before the activity.	<p>Show slide 4.</p> <p>It's time to show what you know about forces and motion! In a moment, I'll give each team a card that describes a real-life scenario.</p> <p>Your team will explain one of the five different scenarios on the slide:</p> <ol style="list-style-type: none"> 1. Two students arm wrestling 2. Two groups of children in a tug-of-war 		

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			<p>3. Two people in different types of shoes walking across an icy parking lot</p> <p>4. Playing on a Slip 'N Slide with and without water</p> <p>5. One student holding a ball in the air and another student dropping the ball</p> <p>You'll use everything you've learned about forces and motion in this unit to explain and illustrate the forces acting on an object or objects in the scenario. Especially keep in mind the ideas about forces and motion from our cotton-ball investigation.</p> <p>NOTE TO TEACHER: <i>Distribute one scenario from handout 6.1 (Scenario Cards) to each team. Then give each student on a team the corresponding picture for the team scenario from handout 6.2 (Scenario Pictures).</i></p> <p>Make sure every team member can see the pictures and the words on the scenario card.</p>		
10 min	<p>Activity</p> <p>Synopsis: Teams identify and illustrate the forces acting on the object(s) in their scenarios. Then they decide how to act out these forces using foam-board arrows and other props.</p>	Engage students in using and applying new science ideas in a variety of ways and contexts.	<p>Show slide 5.</p> <p>Have one person on your team read the scenario aloud. Then look carefully at the pictures on your scenario card.</p> <p>Next, discuss the scenario with your teammates and work together to identify and describe all of the forces—the pushes and pulls—that cause the people or objects in your scenario to start</p>		

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	<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 motion and involves an interaction between two objects. A force can cause an object to start moving, speed up, slow down, change direction, or stop moving. <i>Friction</i> is a force that pushes in the opposite direction of an object’s motion. Rougher (bumpier) surfaces generate more friction between objects. <i>Gravity</i> is a force that consistently pulls an object toward Earth. Each of these science ideas about forces can help us predict and explain motion in everyday situations. 	<p>Select content representations and models matched to the learning goal and engage students in their use.</p> <p>Make explicit links between science ideas and activities during the activity.</p>	<p>moving, change speed or direction, or stop moving.</p> <p>You’ll use arrows to represent the forces that act on objects or people in your scenario. And some scenarios ask you to draw bumps on the surfaces of objects to show the force of friction.</p> <p>Before you draw any arrows or bumps on your pictures, make sure to talk about <i>both</i> the direction and the strength or size of the forces.</p> <p>Once you agree as a team on the strength and direction of the forces acting on the people or object(s), you can draw the arrows or bumps on your own pictures.</p> <p>You’ll have 5 minutes to draw the arrows and any bumps representing the forces in your scenario, so you’ll need to stay focused on the task.</p> <p>NOTE TO TEACHER: <i>Make sure visual and language resources are available to students throughout the activity. Remind students in a visual way that arrows represent the strength of the forces acting on an object, and the length of an arrow represents the size of the force.</i></p> <p>Show slide 6.</p> <p>Now that you’ve finished identifying and drawing the forces in your scenarios, talk about</p>		

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		<p>Highlight key science ideas and focus question throughout.</p> <p>Ask questions to probe student ideas and predictions.</p> <p>Ask questions to challenge</p>	<p>how your team can act out these forces for the class using the foam arrows.</p> <p>As you plan your skits, keep our focus question in mind: <i>How can ideas about forces help us explain the motion of objects?</i></p> <p>Decide as a team who will act out the forces in the scenario and who will hold up the arrows. You'll also need to decide which arrows you'll use to represent the strength and direction of the forces.</p> <p>You'll have only 5 minutes to discuss how you'll act out the scenario, so stay focused and cooperate with one another to make sure you're ready to present your skit to the class when it's time.</p> <p>When your team has decided how to represent all of the forces in your pictures with arrows, I'll give you some other props you can use to act out your scenario for the class.</p> <p>NOTE TO TEACHER: <i>Circulate among the teams as they discuss their scenarios. Probe their thinking about the forces that cause a person or object to start moving, change speed or direction, or stop moving. Challenge students to consider forces they might not initially think of, such as gravity or friction.</i></p> <p>ELL support: Listen carefully to what ELL</p>		

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		student thinking.	<p>students are saying during the team discussions and note any misconceptions or confusion that may provide a basis for a class science talk.</p> <p>NOTE TO TEACHER: <i>If there are errors or omissions on a team's pictures, don't correct them at this point. Instead, ask probe or challenge questions to nudge students in the right direction. Also jot down any issues to you would like to address with each group. Classmates may provide valuable feedback during the team presentations that may challenge any misconceptions or help clear up any confusion about science concepts.</i></p>		<p><i>Questions to ask as teams develop their skits:</i></p> <ul style="list-style-type: none"> • What does this arrow represent? • What's happening here? • Are there any forces you might be forgetting?
15 min	<p>Follow-Up to Activity</p> <p>Synopsis: Teams present their skits to the class, demonstrating the forces acting on the object(s) in their scenarios and explaining why the object(s) moved or didn't move.</p> <p>Main science idea(s):</p> <ul style="list-style-type: none"> • <i>Forces</i> are pushes and pulls that change an object's motion. If we know the strength (size) and direction of the forces acting on an object, we can predict 	<p>Select content representations and models matched to the learning goal and engage students in their use.</p> <p>Engage students in constructing explanations and arguments.</p> <p>Engage</p>	<p>Show slide 7.</p> <p>It's time for the Physics Players to take the stage in our <i>Forces and Motion</i> skits!</p> <p>Are you ready to act out your scenarios for the class?</p> <p>Your team will have 2 or 3 minutes to act out the forces in your scenario. Use your props to demonstrate the action that's taking place, and use arrows to represent the direction and strength of the forces involved.</p> <p>As each team acts out the forces in their scenario, watch and listen carefully. Don't interrupt during the skit. You'll have an opportunity to ask questions and offer comments</p>		

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	and explain whether or not it will move and in what direction.	students in communicating in scientific ways.	<p>afterward.</p> <p>Let's start with the arm-wrestling scenario.</p> <p>NOTE TO TEACHER: <i>Keep track of the time as each team presents their skit. One team member should demonstrate the action taking place in the scenario, and another should use arrows to represent the direction and size of the forces involved.</i></p> <p><i>After each team completes their skit, invite students to ask questions or offer comments about the forces represented in the scenario.</i></p> <div style="text-align: center;">  <p><i>Embedded Assessment Task</i></p> </div> <p>NOTE TO TEACHER: <i>As teams present their skits, listen for descriptions of the two objects that are in contact (for nongravitational forces) and the strength and direction of the forces acting on the objects or people in their scenarios. Encourage presenters to describe the force that causes an object/person to start moving, any forces that are involved in a change in speed or direction, and the force that causes an object/person to slow down and/or stop moving. Also encourage presenters to describe the forces and objects/people involved as specifically as possible.</i></p>		

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			<p><i>Following the skit, listen for questions from the audience about forces that might be missing from the presentation or about the strengths of the forces involved.</i></p>		
10 min	<p>Synthesize/Summarize Today’s Lesson</p> <p>Synopsis: Students write their best answers to the unit central questions in their science notebooks and include specific examples from the lesson sequence to support their ideas.</p> <p>Main science idea(s):</p> <ul style="list-style-type: none"> • <i>Forces</i> are pushes or pulls that change an object’s motion and involve an interaction between two objects. A force can cause an object to start moving, speed up, slow down, change direction, or stop moving. <i>Friction</i> is a force that pushes in the opposite direction of an object’s motion. <i>Gravity</i> is a force that consistently pulls an 	<p>Engage students in making connections by synthesizing and summarizing key science ideas.</p> <p>Highlight key science ideas and focus question throughout.</p>	<p>Show slide 8.</p> <p>Great job, Physics Players! You showed just how much you’ve learned about forces and motion in this unit!</p> <p>Let’s revisit our unit central questions: <i>What makes something start to move? What makes something stop moving or change direction?</i></p> <p>Show slide 9.</p> <p>Today we also explored the focus question, <i>How can ideas about forces help us explain the motion of objects?</i></p> <p>In our first lesson, I asked you to think of examples of moving objects and share your ideas about what made it start moving and what would make it stop moving. Let’s look at the examples and ideas I charted during our class discussion.</p> <p>NOTE TO TEACHER: <i>Display the chart of examples and ideas from lesson 1a throughout this discussion.</i></p> <p>Show slide 10.</p>		

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	<p>object toward Earth. Each of these science ideas about forces can help us predict and explain motion in everyday situations.</p>		<p>Think-Pair-Share: Think about your initial ideas for answering these questions from our first lesson and share them with an elbow partner. Then talk about the questions on the slide:</p> <ul style="list-style-type: none"> • How do your ideas for answering these questions today differ from your initial ideas? • Were some of your initial ideas wrong? How so? • Did your initial ideas about an object’s motion include pushes or pulls, gravity, or friction? • Based on what you now know about forces and motion, how would you change your initial ideas to make them more correct and complete? <p>Show slide 11.</p> <p>Once you and your partner have discussed these questions, write your best answers to the unit central questions in your science notebooks using complete sentences. Include science ideas and evidence from our investigations, and make sure to use the words <i>force</i>, <i>friction</i>, <i>gravity</i>, and <i>moving</i> or <i>move</i> in your answers.</p> <p>Also keep in mind our focus question, <i>How can ideas about forces help us explain the motion of objects?</i></p>		

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			<p>ELL support: Be explicit about what a complete sentence means and show ELL students an example. Include multimodal responses in this activity, allowing (or requiring) ELL students to draw what they're writing about.</p> <p>After you and your partner have written your answers, share them with each other and suggest ways each of you might improve your answers by making them clearer, more complete, or more accurate. If you think your partner's suggestions will improve your answer, you can make changes.</p> <p>ELL support: Circulate among the pairs as they share their answers and feedback. Provide additional feedback in a formative way to help students improve their responses.</p> <p>Whole-class share-out (optional): Who would like to briefly share your final answers to our unit central questions with the class?</p> <p>NOTE TO TEACHER: <i>If time allows, invite a few students to share their final responses to the unit central questions with the class. Highlight and chart key science ideas they express that match the module learning goals. Probe incomplete or incorrect answers to help students clearly articulate their new understandings as fully and accurately as possible.</i></p>		

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1 min	<p>Link to Future Lessons</p> <p>Synopsis: The teacher links science ideas about forces and motion to future lessons.</p>	<p>Summarize key science ideas.</p> <p>Link science ideas to other science ideas.</p>	<p>Show slide 12.</p> <p>In this unit, we explored the forces that cause objects on Earth to move in different ways. We learned how forces like friction and gravity are involved in an object’s motion, and we used arrows to show the direction and strength of those forces. We also figured out what happens when more than one force acts on an object.</p> <p>Today you brought all of these science ideas together in a skit that showed how forces and motion work in real-life scenarios.</p> <p>We’ll continue building on these important science ideas in future lessons, so stay tuned!</p> <p>NOTE TO TEACHER: <i>Highlight how the ideas about forces and motion link to future science lessons. Help students create a coherent storyline that links science ideas to other science ideas.</i></p>		