

# Forces

## Lesson 5b: Equal and Unequal Forces

<b>Grade 3</b>	<b>Length of lesson:</b> 50 minutes	<b>Placement of lesson in unit:</b> 5b of 6 two-part lessons on forces
<b>Unit central questions:</b> What makes something start to move? What makes something change direction or stop moving?		<b>Lesson focus question:</b> What happens if more than one force pushes or pulls an object?
<b>Main learning goal:</b> If gravity is pulling down on an object but the object isn't moving, there must be a force of equal strength pulling up on the object. If the upward force is stronger or weaker than the force of gravity, the object will move in the direction of the stronger force.		
<b>Science content storyline:</b> More than one force can push or pull an object at the same time. If two forces of <i>equal</i> strength are pushing or pulling an object in opposite directions, the object won't move. But if forces of <i>unequal</i> strength are pushing or pulling an object in opposite directions, the object will move in the direction of the stronger force. Forces can push side to side, but they can also push up and down. On Earth, gravity always pulls objects toward the ground, so if an object isn't moving, something else, such as the floor, a chair, or a table, is pushing up on it with equal force. For example, when a pencil is sitting still on a desk, the force of gravity is pulling down on it, and the table is pushing up on it at the same time with equal force.		
<b>Ideal student response to the focus question:</b> More than one force can push or pull an object at the same time. If forces of the same size (equal strength) are pushing or pulling an object in opposite directions, the object won't move. But if forces of different sizes (unequal strength) are pushing or pulling the object in opposite directions, the object will move in the direction of the stronger force. On Earth, gravity is always pulling objects toward the ground, so if an object isn't moving—like a pencil sitting on a table—something else must be pushing up on it with the same force.		

### Preparation

<p><b>Materials Needed</b></p> <ul style="list-style-type: none"> <li>• Science notebooks</li> <li>• Chart paper and markers</li> <li>• 6 foam-board arrows of different lengths (2 short, 2 medium, and 2 long) (1 set from lesson 2a)</li> <li>• Rolling cart (from lesson 1a)</li> </ul> <p><b>Student Handouts</b></p> <ul style="list-style-type: none"> <li>• 5.1 Describe the Forces (Part 2) (1 per student)</li> </ul>	<p><b>Ahead of Time</b></p> <ul style="list-style-type: none"> <li>• Review section 4 (Net Forces) in the content background document.</li> <li>• <b>ELL support:</b> Prepare visual and language resources (e.g., a word wall) for ELL students to refer to throughout the lesson.</li> </ul>
---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

## Lesson 5b General Outline

Time	Phase of Lesson	How the Science Content Storyline Develops
8 min	<b>Link to previous lesson:</b> Students review the three scenarios they investigated in the previous lesson and discuss their findings.	<ul style="list-style-type: none"> <li>More than one force can push or pull an object at the same time. If two forces of <i>equal</i> strength are pushing or pulling an object in opposite directions, the object won't move. But if forces of <i>unequal</i> strength are pushing or pulling an object in opposite directions, the object will move in the direction of the stronger force.</li> </ul>
1 min	<b>Lesson focus question:</b> The teacher reviews the focus question from the previous lesson: <i>What happens if more than one force pushes or pulls an object?</i>	
5 min	<b>Setup for activity:</b> Students share their initial ideas about whether any forces are acting on a pencil that's sitting still on a table.	
20 min	<b>Activity:</b> Students apply science ideas about equal and unequal forces as they describe and illustrate the forces acting on a pencil and a piece of wood in two scenarios. They also consider gravity as one of the forces acting on an object at rest.	<ul style="list-style-type: none"> <li>On Earth, gravity is constantly pulling objects toward the ground, so if an object isn't moving, something else, such as the floor, a chair, or a table, is pushing up on it with equal force.</li> </ul>
8 min	<b>Follow-up to activity:</b> Students share their ideas about the equal and unequal forces acting on the pencil and the piece of wood in the two scenarios. They also discuss how the force of gravity is involved in each scenario and help one another build stronger understandings of this science idea.	<ul style="list-style-type: none"> <li>More than one force can push or pull an object at the same time. If the force of gravity is pulling an object toward the ground, but the object doesn't move, another force is acting on the object in the opposite direction. If the force of gravity is pulling an object toward the ground, and the object moves in the opposite direction, a stronger force is pushing the object in that direction.</li> </ul>
7 min	<b>Synthesize/summarize today's lesson:</b> The teacher reviews the scenarios on the handout in light of the focus question. Then students complete two sentences that summarize their understandings of multiple forces and the movement of objects.	<ul style="list-style-type: none"> <li>More than one force can push or pull an object at the same time. We can predict the motion of an object by adding the forces together. If forces of <i>equal</i> strength are acting on an object in opposite directions, the object will remain at rest. But if forces of <i>unequal</i> strength are acting on an object in opposite directions, the object will move in the direction of the stronger force.</li> </ul>
1 min	<b>Link to next lesson:</b> The teacher announces that in the next lesson, students will use all of the science ideas they've learned about forces and motion in this unit to predict and explain the motion of objects in real life.	

Time	Phase of Lesson and How the Science Content Storyline Develops	STeLLA Strategy	Teacher Talk and Questions	Anticipated Student Responses	Possible Probe/Challenge Questions
8 min	<p><b>Link to Previous Lesson</b></p> <p><b>Synopsis:</b> Students review the three scenarios they investigated in the previous lesson and discuss their findings.</p> <p><b>Main science idea(s):</b></p> <ul style="list-style-type: none"> <li>• More than one force can push or pull an object at the same time. If two forces of <i>equal</i> strength are pushing or pulling an object in opposite directions, the object won't move. But if forces of <i>unequal</i> strength are pushing or pulling an object in opposite directions, the object will move in the direction of the stronger force.</li> </ul>	Link science ideas to other science ideas.	<p><b>Show slides 1 and 2.</b></p> <p>In our last lesson, we investigated three scenarios related to moving a file cabinet. Let's review what we discovered.</p> <p><b>Turn and Talk:</b> Locate your handouts from last time. Then talk about the questions on the slide with an elbow partner:</p> <ul style="list-style-type: none"> <li>• What happened when the force that friction exerted on the file cabinet and the force Sarah exerted were <i>equal</i> (the same)?</li> <li>• What happened when the force that friction exerted on the file cabinet and the force Sarah exerted were <i>unequal</i> (not the same)?</li> <li>• In which scenario or scenarios did the cabinet move?</li> </ul> <p>Look at the arrows in your completed diagrams to help you. In which diagrams are the arrows the same size, or equal? In which diagrams are the arrows not the same size, or not equal?</p> <p><b>Whole-class discussion:</b> Let's have one pair come to the front of the room and show us with the foam arrows what happens when the forces acting on the cabinet are <i>equal</i>, or the same. One partner will represent the girl pushing the file</p>		

Time	Phase of Lesson and How the Science Content Storyline Develops	STeLLA Strategy	Teacher Talk and Questions	Anticipated Student Responses	Possible Probe/Challenge Questions
			<p>cabinet, and the other partner will represent the friction between the bottom of the cabinet and the floor.</p> <p>What does the length, or size, of the arrows represent?</p> <p>So which arrows will you choose to represent equal forces?</p> <p>What does everyone think? Will the cabinet move if the forces acting on it are the same?</p> <p><b>NOTE TO TEACHER:</b> <i>If students are still confused about equal and unequal forces, have them use the rolling cart to demonstrate what happens when equal and unequal forces act on an object. Then have them relate the cart demonstration to the diagrams of the girl pushing the file cabinet.</i></p> <p>Now let's have our volunteers show us with the arrows what will happen when the forces acting on the cabinet are <i>unequal</i>, or not the same.</p> <p>Which arrows will you choose to represent unequal forces?</p> <p>Will the cabinet move if the forces acting on it aren't the same? In what direction will</p>	<p>How strong the force is.</p>	


Time	Phase of Lesson and How the Science Content Storyline Develops	STeLLA Strategy	Teacher Talk and Questions	Anticipated Student Responses	Possible Probe/Challenge Questions
			it move?		
1 min	<p><b>Lesson Focus Question</b></p> <p><b>Synopsis:</b> The teacher reviews the focus question from the previous lesson: <i>What happens if more than one force pushes or pulls an object?</i></p>	<p>Set the purpose with a <u>focus question</u> or goal statement.</p>	<p><b>Show slide 3.</b></p> <p>Our focus question for today is the same question we explored last time: <i>What happens if more than one force pushes or pulls an object?</i></p> <p>We just demonstrated the answer to this question with our foam arrows, didn't we?</p> <p>Today we'll add the force of gravity to our investigation of forces that act on an object. Throughout this lesson, keep in mind what we learned about the forces acting on a heavy file cabinet.</p>		
5 min	<p><b>Setup for Activity</b></p> <p><b>Synopsis:</b> Students share their initial ideas about whether any forces are acting on a pencil that's sitting still on a table.</p>	<p>Make explicit links between science ideas and activities <b>before</b> the activity.</p> <p>Ask questions to elicit student ideas and predictions.</p>	<p><b>Show slide 4.</b></p> <p>Look at this picture of a pencil lying on a table. What do you notice about the pencil?</p> <p>That's right! The pencil is sitting perfectly still on the table.</p> <p>Do you think any forces are acting on the pencil?</p> <p><b>Turn and Talk (2 min):</b> Talk about this question with an elbow partner and explain your reasoning. Be prepared to share your ideas and explanations with the class.</p>	<p>It isn't moving.</p>	

Time	Phase of Lesson and How the Science Content Storyline Develops	STeLLA Strategy	Teacher Talk and Questions	Anticipated Student Responses	Possible Probe/Challenge Questions
		Engage students in communicating in scientific ways.	<p><b>Whole-class share-out:</b> Let’s hear some of your ideas. Do you think any forces are acting on the pencil if it isn’t moving?</p> <p><b>NOTE TO TEACHER:</b> <i>During this discussion, encourage students to agree or disagree, ask questions, or add other ideas and explanations. Ask students to back up their ideas with reasoning. At this point, accept all ideas without correcting misconceptions or inaccuracies.</i></p> <p>These are good ideas to start with. Today we’ll explore some other ideas about why the pencil doesn’t move.</p>	<p>We don’t think there are any forces acting on the pencil. That’s why it’s not moving. <i>[Misconception]</i></p> <p>We think gravity is pulling the pencil, but no forces are pulling or pushing it side to side. <i>[Misconception]</i></p> <p>Maybe gravity is pulling the pencil, but it isn’t moving because the table is in the way. <i>[Misconception]</i></p>	<p>Can anyone think of a force that might be pushing or pulling the pencil?</p> <p>If the force of gravity is pulling the pencil, why isn’t it moving?</p>

Time	Phase of Lesson and How the Science Content Storyline Develops	STeLLA Strategy	Teacher Talk and Questions	Anticipated Student Responses	Possible Probe/Challenge Questions
20 min	<p><b>Activity</b></p> <p><b>Synopsis:</b> Students apply science ideas about equal and unequal forces as they describe and illustrate the forces acting on a pencil and a piece of wood in two scenarios. They also consider gravity as one of the forces acting on an object at rest.</p> <p><b>Main science idea(s):</b></p> <ul style="list-style-type: none"> <li>On Earth, gravity is constantly pulling objects toward the ground, so if an object isn't moving, something else, such as the floor, a chair, or a table, is pushing up on it with equal force.</li> </ul>	<p>Make explicit links between science ideas and activities <b>during</b> the activity.</p> <p>Engage students in using and applying new science ideas in a variety of ways and contexts.</p> <p>Ask questions to elicit student ideas and predictions.</p>	<p>Some of you said you don't think any forces are acting on the pencil if it isn't moving. Others think that some other force like gravity might be pulling down on the pencil.</p> <p>Let me give you a little hint.</p> <p><b>Show slide 5. (Reveal only the downward-pointing arrow.)</b></p> <p>What do you think would happen to the pencil if we took away the table?</p> <p><b>Turn and Talk:</b> Discuss this question with your partner and make sure to include reasons to support your ideas.</p> <p><b>Whole-class share-out:</b> What ideas did you come up with to explain what would happen to the pencil if we took the table away?</p>	<p>We think the pencil would fall to the ground if we took the table away.</p> <p>The table is in the way. [Misconception]</p>	<p>Why isn't the pencil falling to the ground when the table is there?</p> <p>Does that mean that the table is exerting a force?</p>

Time	Phase of Lesson and How the Science Content Storyline Develops	STeLLA Strategy	Teacher Talk and Questions	Anticipated Student Responses	Possible Probe/Challenge Questions
			<p>Give me a thumbs-up if you agree that gravity is pulling down on the pencil?</p> <p>Right! Gravity is one of the forces acting on the pencil.</p> <p><b>Continue showing slide 5. (Reveal the word <i>Gravity</i>.)</b></p> <p>Do we all agree that the table must be exerting a force on the pencil that's pushing up at the same time gravity is pulling down?</p> <p>Give me a thumbs-up if you agree, and a thumbs-down if you disagree.</p> <p><b>NOTE TO TEACHER:</b> <i>If students are having a difficult time grasping this idea, review what happens to the pencil when the table is taken away and link this to what happens when equal forces act on an object in opposite directions. Students should reach the conclusion that an opposing force must be acting on the pencil if it doesn't move when gravity is pulling on it.</i></p> <p>So we've identified the <i>direction</i> of the force the table is exerting on the pencil. But what about the size or strength of the force?</p>	<p>I guess so. The table must be pushing up while gravity pushes down.</p>	



Time	Phase of Lesson and How the Science Content Storyline Develops	STeLLA Strategy	Teacher Talk and Questions	Anticipated Student Responses	Possible Probe/Challenge Questions
			<p>If the pencil isn't moving, what size would the arrow representing the force of the table have to be?</p> <p>Think about what we learned about equal and unequal forces with the file cabinet.</p> <p>Good answer!</p> <p><b>Show slide 6.</b></p> <p>Today, we'll investigate two scenarios that involve the force of gravity.</p> <p><b>NOTE TO TEACHER:</b> <i>Distribute part 2 of handout 5.1 (Describe the Forces).</i></p> <p> <b><i>Embedded Assessment Task</i></b></p>	<p>Just like before when the girl was pushing on the cabinet, I guess the arrow for the table would have to be the same size as the arrow for gravity.</p> <p>If they were different sizes, the pencil would move.</p>	<p>Why do you say that both arrows would have to be the same size?</p>

Time	Phase of Lesson and How the Science Content Storyline Develops	STeLLA Strategy	Teacher Talk and Questions	Anticipated Student Responses	Possible Probe/Challenge Questions
			<p>We've already talked about the first scenario involving the pencil at rest on the table, but I'd like you to complete the tasks for this scenario on the handout based on our discussion. You should be able to do this in a couple of minutes.</p> <p><b>NOTE TO TEACHER:</b> <i>Introduce the final scenario and briefly review the directions. Then ask students whether they have any questions before they begin the activity.</i></p> <p>This scenario is about two friends building a tree fort. You may talk about both parts of the scenario with a partner, but complete the handout tasks on your own.</p> <p>Make sure to draw arrows on both diagrams to represent the forces acting on the piece of wood. Then write your best answers to the questions. As you complete these tasks, keep in mind what you know about gravity.</p> <p><b>ELL support:</b> Preview the scenario with ELL students to make sure they understand the content and what they're being asked to do.</p>		
8 min	<p><b>Follow-Up to Activity</b></p> <p><b>Synopsis:</b> Students share</p>	Engage	<p><b>Show slide 7.</b></p> <p>Let's have a volunteer come up and talk us</p>		

Time	Phase of Lesson and How the Science Content Storyline Develops	STeLLA Strategy	Teacher Talk and Questions	Anticipated Student Responses	Possible Probe/Challenge Questions
	<p>their ideas about equal and unequal forces acting on the pencil and piece of wood in the two scenarios. They also discuss how the force of gravity is involved and help one another build stronger understandings of this science idea.</p> <p><b>Main science idea(s):</b></p> <ul style="list-style-type: none"> <li>• More than one force can push or pull an object at the same time. If the force of gravity is pulling an object toward the ground, but the object doesn't move, another force is acting on the object in the opposite direction. If the force of gravity is pulling an object toward the ground, and the object moves in the opposite direction, a stronger force is pushing the object in that direction.</li> </ul>	<p>students in constructing explanations and arguments.</p> <p>Ask questions to probe student ideas and predictions.</p> <p>Ask questions to challenge student thinking.</p> <p>Engage students in communicating in scientific ways.</p>	<p>through your drawings and explanations for both scenarios on the handout.</p> <p><b>NOTE TO TEACHER:</b> <i>Select a volunteer to display her or his handout on the document reader and share the drawings and explanations for each scenario. Ask questions to probe and challenge student thinking. Direct students to listen carefully to their classmate's explanations and consider whether their ideas make sense. Encourage them to agree or disagree, ask clarifying questions, or add on to the ideas. As time allows, invite other students to share their drawings and explanations.</i></p> <p><i>After this discussion, ask students whether any of their ideas about the forces acting on the pencil or piece of wood have changed. If possible, give them time to revise their drawings and explanations on the handout so they're scientifically accurate.</i></p> <p><b>ELL support:</b> Orient ELL students to the tasks in part 2 of handout 5.1 and be explicit about expectations.</p>		
7 min	<b>Synthesize/Summarize Today's Lesson</b>		In this unit on forces, we've learned what makes an object start moving, slow down and eventually stop. We've also explored		

Time	Phase of Lesson and How the Science Content Storyline Develops	STeLLA Strategy	Teacher Talk and Questions	Anticipated Student Responses	Possible Probe/Challenge Questions
	<p><b>Synopsis:</b> The teacher reviews the scenarios on the handout in light of the focus question. Then students complete two sentences that summarize their understandings of multiple forces and the movement of objects.</p> <p><b>Main science idea(s):</b></p> <ul style="list-style-type: none"> <li>• More than one force can push or pull an object at the same time. We can predict the motion of an object by adding the forces together. If forces of <i>equal</i> strength are acting on an object in opposite directions, the object will remain at rest. But if forces of <i>unequal</i> strength are acting on an object in opposite directions, the object will move in the direction of the stronger force.</li> </ul>	<p>Highlight key science ideas and focus question throughout.</p> <p>Engage students in making connections by synthesizing and summarizing key science ideas.</p>	<p>science ideas about friction, gravity, and what happens when one or more forces act on an object. Today we learned that forces can even act on an object when it isn't moving!</p> <p><b>Show slide 8.</b></p> <p>Let's review the scenarios on our handouts and think about how they relate to today's focus question, <i>What happens if more than one force pushes or pulls an object?</i></p> <p>In all of the scenarios, you drew more than one arrow to represent the forces acting on an object.</p> <p>First, let's think about the objects on the handout that <i>didn't</i> move. What happened with the arrows (forces) in those scenarios?</p>	<p>If something isn't moving, the arrows are pointing in opposite directions.</p> <p>It means that the forces are pushing or pulling the object in</p>	<p>What do you mean by "the arrows are pointing in opposite directions"? Can you say this using the word <i>forces</i>?</p>

Time	Phase of Lesson and How the Science Content Storyline Develops	STeLLA Strategy	Teacher Talk and Questions	Anticipated Student Responses	Possible Probe/Challenge Questions
			<p>Now let's think about the objects that <i>did</i> move. What happens with the forces or arrows in those scenarios?</p>	<p>opposite directions.</p> <p>The arrows would have to be the same size.</p> <p>If an object doesn't move, the forces pushing or pulling it would be the same strength and point in opposite directions.</p> <p>If the forces aren't the same or equal, the arrows would have to be a different size.</p> <p>They're still pointing in opposite directions, but the forces aren't the same, so the object moves.</p>	<p>How big would the arrows be to represent the size of these forces?</p> <p>Could you use the science idea of forces to explain this?</p> <p>In what direction are the arrows pointing?</p>

Time	Phase of Lesson and How the Science Content Storyline Develops	STeLLA Strategy	Teacher Talk and Questions	Anticipated Student Responses	Possible Probe/Challenge Questions
		<p>Summarize key science ideas.</p> <p>Highlight key science ideas and focus question</p>	<p><b>Show slide 9.</b></p> <p>Using the sentence starters on the slide, answer the focus question in your notebooks.</p> <p><i>If forces of <b>equal</b> (the same) strength are pushing or pulling an object in opposite directions, the object will _____.</i></p> <p><i>If forces of <b>unequal</b> (not the same) strength are pushing or pulling an object in opposite directions, the object will _____.</i></p> <p><b>ELL support:</b> Keep terminology as consistent as possible for ELL students, while also exposing them to multiple forms of a term. Where possible, link the terms <i>equal</i> and <i>unequal</i> with the synonyms <i>the same</i> and <i>not the same</i>.</p> <p><b>NOTE TO TEACHER:</b> <i>If time allows, ask a few students to read their final responses aloud to the class. Highlight the science ideas they express that match the module learning goals. Probe any incomplete answers to help students</i></p>	<p>It moves in the direction of the stronger force.</p>	<p>In what direction does the object move?</p>

Time	Phase of Lesson and How the Science Content Storyline Develops	STeLLA Strategy	Teacher Talk and Questions	Anticipated Student Responses	Possible Probe/Challenge Questions
		<p>throughout.</p> <p>Ask questions to probe student ideas and predictions.</p>	<p><i>produce complete sentences that clearly articulate their new understandings.</i></p>		
1 min	<p><b>Link to Next Lesson</b></p> <p><b>Synopsis:</b> The teacher announces that in the next lesson, students will use all of the science ideas they've learned about forces and motion in this unit to predict and explain the motion of objects in real life.</p>	<p>Make explicit links between science ideas and activities.</p>	<p><b>Show slide 10.</b></p> <p>In the next lesson, you'll use everything you've learned about forces and motion in this unit to predict and explain the motion of objects in real life.</p> <p>Are you ready to show what you know?</p>		