# Forces
# Lesson 6a: Predicting Motion in Real-life Situations

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| **Grade 3** | **Length of lesson:** 40 minutes | **Placement of lesson in unit:** 6a 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 predict the motion of objects? |
| **Main learning goal:** Ideas about forces can help us predict the motion of objects. | | |
| **Science content storyline:** A *force* 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. *Friction* is a force that pushes in the opposite direction of an object's motion. Rougher (bumpier) surfaces generate greater friction between objects. *Gravity* is a force that consistently pulls an object toward Earth. Each of these science ideas about forces can help us predict 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 whether or not it will move and in what direction. | | |

**Preparation**

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| **Materials Needed**<br>• Science notebooks<br>• Chart paper and markers<br>• Portable fan<br>• Small cotton balls (See Ahead of Time.)<br>• 6 foam-board arrows of different lengths (2 short, 2 medium, and 2 long) | **Ahead of Time**<br>• Review the content background document. Pay special attention to figure 4 in section 4 (Net Forces) and the paragraph that discusses forces acting on a cotton ball. Prepare this figure for display on a document reader at the end of the activity follow-up.<br>• Cut a few large cotton balls into quarters for the cotton-ball investigation. Large cotton balls are too big to fly in the wind current of a portable fan. To make sure the size will work, drop a cotton ball in front of the fan at the highest speed.<br>• **ELL support:** Prepare visual and language resources for the Tier 2 words (less common) and Tier 3 words (disciplinary/specialized in this unit). |

**Lesson 6a General Outline**

| Time | Phase of Lesson | How the Science Content Storyline Develops |
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| 6 min | **Link to previous lesson:** The teacher engages students in a review of key science ideas about forces from previous lessons. | • *Forces* are pushes or pulls that cause an object's motion to change. Forces involve an interaction between two objects. In most cases, the objects must touch to create a force.<br>• *Gravity* is a special type of force that pulls an object toward Earth without requiring it to touch the ground.<br>• *Friction* is a force that acts in the opposite direction of an object's motion, causing the object to slow down and stop. Friction is created when tiny bumps on the surfaces of two objects push against one another.<br>• On Earth, gravity is always pulling objects toward the ground, so if an object isn't moving, it means that some other force is pushing the object in the opposite direction of gravity. |
| 1 min | **Lesson focus question:** The teacher introduces the focus question, *How can ideas about forces help us predict the motion of objects?* | |
| 8 min | **Setup for activity:** Students predict the motion of a cotton ball after it's dropped in front of a rotating fan and draw pictures to illustrate their predictions. | |
| 10 min | **Activity:** After discussing their predictions with a partner, students share their ideas with the class. Then they test their predictions by dropping cotton balls in front of a rotating fan and observing what happens. Following the investigation, students compare their predictions with the actual motion of the cotton ball and revise their drawings. | • *Forces* are pushes or pulls that cause an object's motion to change.<br>• At least three forces are involved in the cotton-ball experiment. The force of gravity pulls the cotton ball toward the ground. Wind from a fan creates a force that causes the cotton ball to move forward as it falls. And the force of friction causes the cotton ball to slow down and stop moving once it hits the ground. |
| 8 min | **Follow-up to activity:** Students use foam arrows to show the strength and direction of the forces acting on a cotton ball. Then they apply what they know about forces to describe the resulting motion of the cotton ball. | • *Forces* are pushes or pulls that change an object's motion. A force can cause an object to start moving, change direction, speed up, slow down, or stop moving. |
| 6 min | **Synthesize/summarize today's lesson:** Students share how science ideas about forces helped them predict and describe the motion of a cotton ball dropped in front of a rotating fan. | • *Forces* are pushes or 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 whether or not it will move and in what direction. |
| 1 min | **Link to next lesson:** The teacher announces that in the final lesson of the unit, students will show what they know by acting out forces and the motion of objects in real-life scenarios. | |

| Time | Phase of Lesson and How the Science Content Storyline Develops | STeLLA Strategy | Teacher Talk and Questions | Anticipated Student Responses | Possible Probe/Challenge Questions |
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| 6 min | **Link to Previous Lesson**<br><br>**Synopsis:** The teacher engages students in a review of key science ideas about forces from previous lessons.<br><br>**Main science idea(s):**<br>• *Forces* are pushes or pulls that cause an object's motion to change. Forces involve an interaction between two objects. In most cases, the objects must touch to create a force.<br>• *Gravity* is a special type of force that pulls an object toward Earth without requiring it to touch the ground.<br>• *Friction* is a force that acts in the opposite direction of an object's motion, causing the object to slow down and stop. Friction is created when tiny bumps on the surfaces of two objects push against one another.<br>• On Earth, gravity is always pulling objects | Link science ideas to other science ideas.<br><br>Summarize key science ideas. | **Show slides 1 and 2.**<br><br>In this unit, we've been talking about the forces that make an object start moving, change speed or direction, or stop moving.<br><br>Who can give me their best definition of a *force*?<br><br>**ELL support:** Review the distinctions between a definition and an example so that ELL students understand what you're asking. | A *force* is a push or pull.<br><br>A force makes you do something.<br><br>A force doesn't have to be a push or a pull from someone or something that's alive. It can also come from something like the floor or the sidewalk. | Can you give an example of a push or pull from our investigations in previous lessons?<br><br>What do you mean by "do something"? What does a force make you do?<br><br>Can you give me an example of the floor or the sidewalk exerting a force? |

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| | toward the ground, so if an object isn't moving, it means that some other force is pushing the object in the opposite direction of gravity. | | | An example is a pencil sitting on a table.<br><br>A force could be when something falls down, like from the pull of gravity.<br><br>*Gravity* is the pull of Earth on objects.<br><br>Gravity is the same as other forces because it's a pull, but it's different because you don't have to be touching the ground for gravity to pull you toward Earth. | How does the table exert a force if the pencil doesn't move?<br><br>Tell me more about gravity.<br><br>Can anyone tell me more about gravity? How it is similar to or different from other forces? |
| | | | Why do you think it's important to learn about forces?<br><br>What about gravity and friction? Why would it be important to know about these forces? | | |

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| | | | How might an understanding of forces help you in your everyday life? | It would help to know that a soccer ball will go farther if I kick it on a smooth surface than if I kick it on a rough surface.<br><br>Now I know why some things are more slippery, like a slide on the playground. They don't have as much friction. | |
| 1 min | **Lesson Focus Question**<br><br>**Synopsis:** The teacher introduces the focus question, *How can ideas about forces help us predict the motion of objects?* | Set the purpose with a focus question or goal statement. | **Show slide 3.**<br><br>Our focus question for this lesson is *How can ideas about forces help us predict the motion of objects?*<br><br>Write this question in your science notebooks and draw a box around it.<br><br>**NOTE TO TEACHER:** *Write the focus question on the board for students to refer to throughout the lesson.*<br><br>You've mentioned a few things already that | | |

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| | | | an understanding of forces might help you predict. Let's see if we can come up with more ideas for answering this question. | | |
| 8 min | **Setup for Activity**<br><br>**Synopsis:** Students predict the motion of a cotton ball after it's dropped in front of a rotating fan and draw pictures to illustrate their predictions. | Make explicit links between science ideas and activities **before** the activity.<br><br>Select content representations and models matched to the learning goal and engage students in their use.<br><br>Ask questions to elicit student ideas and predictions. | In today's investigation, we'll use everyday objects to help us think about the forces involved in making an object start to move, change speed or direction, and eventually stop.<br><br>**Show slide 4.**<br><br>First, let's investigate what happens when some cotton balls are dropped in front of a rotating fan that's running at full speed.<br><br>**NOTE TO TEACHER:** *Use the cotton-ball investigation as a model for what you want students to do with the scenarios in the final lesson of this unit.*<br><br>**Show slide 5.**<br><br>What do you predict will happen when a cotton ball is dropped in front of a fan that's rotating at full speed?<br><br>For now, don't think about the forces acting on the cotton all. Just think about how the cotton ball will move.<br><br>Think about this scenario and then draw a picture in your science notebooks to show | | |

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| | | | how you think the cotton ball will move when it's dropped in front of the fan.<br><br>You don't need to make an elaborate drawing. Just make a rough sketch to show what you predict about the cotton ball's motion. | | |
| 10 min | **Activity**<br><br>**Synopsis:** After discussing their predictions with a partner, students share their ideas with the class. Then they test their predictions by dropping cotton balls in front of a rotating fan and observing what happens. Following the investigation, students compare their predictions with the actual motion of the cotton ball and revise their drawings.<br><br>**Main science idea(s):**<br>• *Forces* are pushes or pulls that cause an object's motion to change.<br>• At least three forces are involved in the cotton-ball experiment. The force of gravity pulls the cotton ball toward the | Make explicit links between science ideas and activities **during** the activity.<br><br>Engage students in using and applying new science ideas in a variety of ways and contexts. | **Show slide 6.**<br><br>**Turn and Talk:** Now I'd like you to share your predictions and drawings with an elbow partner. Describe how you think the cotton ball will move when it's dropped in front of the fan and why you think so.<br><br>For now, don't worry about describing the forces involved. Just focus on the motion of the cotton ball.<br><br>**Whole-class discussion:** Let's hear a few of your predictions. Make sure to show us your drawings and use them to explain your predictions.<br><br>**NOTE TO TEACHER:** *After students have shared their predictions and drawings, ask a few volunteers to describe the motion of the cotton ball and share their ideas and reasoning. As students share their predictions, record their ideas on chart paper.*<br><br>*Listen carefully to see if any students predict* | | |

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| | ground. Wind from a fan creates a force that causes the cotton ball to move forward as it falls. And the force of friction causes the cotton ball to slow down and stop moving once it hits the ground. | | *the following scenario: First, the cotton ball will fall toward the ground. Then when it's in front of the fan, it will move forward or sideways (in the direction the wind is blowing). The cotton ball will continue to move toward the ground while it's moving forward or sideways. When it hits the ground, it will stop.*<br><br>*At this point, accept all predictions, even if they aren't scientifically accurate. Note any misconceptions or confusion you'll need to address during the follow-up discussion.*<br><br>*If students start discussing the forces acting on the cotton ball, let them know they'll discuss these forces later. Then refocus their attention on the cotton ball's motion.*<br><br>So it looks like we have some different ideas about what will happen when the cotton ball is dropped in front of the fan.<br><br>**NOTE TO TEACHER:** *It's unlikely that everyone will agree on the cotton ball's predicted motion. It's OK at this point if students disagree. Leave all options open until you test their predictions.*<br><br>**Show slide 7.**<br><br>Let's test our predictions and see whether the cotton ball moves the way we think it will. | | |

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| | | Select content representations and models matched to the learning goal and engage students in their use. | In a moment, I'll select a few volunteers to drop small cotton balls in front of the rotating fan one at a time. Carefully observe what happens to the motion of each cotton ball when it's dropped in front of the fan.<br><br>Be prepared to share your observations with the class afterward. I'll record them on chart paper so we can track how the cotton balls moved and see if we can identify any patterns.<br><br>**NOTE TO TEACHER:** *Select four volunteers and give each of them a small cotton ball. (Make sure the cotton balls have been cut into quarters. Large cotton balls are too big to fly in the wind current of a portable fan.) Have one student at a time drop a cotton ball in front of the fan as it's rotating at high speed. Caution students to keep their hands well away from the fan's blades.*<br><br>**Show slide 8.**<br><br>Based on our observations, do you agree or disagree with the pattern of motion described on the slide?<br><br>1. When the cotton ball was dropped, it fell toward the ground.<br>2. When the fan blew on the cotton ball, it moved forward *[or sideways]*, but it also continued falling toward the | | |

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| | | | ground.<br>3. When the cotton ball hit the ground, it stopped moving.<br><br>**NOTE TO TEACHER:** *Make sure students agree with this basic pattern of movement. If some students disagree, drop a few more cotton balls in front of the fan and ask them to observe the motion closely.* | | |
| 8 min | **Follow-Up to Activity**<br><br>**Synopsis:** Students use foam arrows to show the strength and direction of the forces acting on a cotton ball. Then they apply what they know about forces to describe the resulting motion of the cotton ball.<br><br>**Main science idea(s):**<br>• *Forces* are pushes or pulls that change an object's motion. A force can cause an object to start moving, change direction, speed up, slow down, or stop moving. | Make explicit links between science ideas and activities **after** the activity.<br><br>Engage students in analyzing and interpreting data and observations.<br><br>Select content representations and models matched to the learning goal and engage students in their use. | **Show slide 9.**<br><br>How might the science idea of *forces* help us explain why the cotton balls moved the way they did?<br><br>Let's have a few volunteers come up one at a time and use the foam arrows to describe the forces acting on each cotton ball.<br><br>First, use the arrows to explain why the cotton ball initially fell toward the ground.<br><br>**NOTE TO TEACHER:** *For each force and change in motion, encourage student volunteers to use their arrows to describe both the strength (size) and the direction of the forces acting on the cotton ball. Also ask them to include in their explanations the objects that were pushing or pulling the cotton ball. In this initial scenario, the cotton ball fell toward the ground because the force of gravity was pulling on it.* | *[Student 1 points an arrow toward the ground.]*<br><br>I used a medium- | Why did you use that particular arrow? How would you describe the force that caused the cotton ball to fall toward the ground? |

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| | | Engage students in communicating in scientific ways. | Does everyone agree with this description?<br><br>Does anyone want to add on, or do you have some different ideas about how we might represent the forces acting on the cotton ball?<br><br>**ELL support:** At this point, it might help ELL students to refer to their initial drawings of force in their notebooks.<br><br>Now use the arrows to explain why the cotton ball moved forward *[or sideways]* when the wind from the fan hit it.<br><br>**NOTE TO TEACHER:** *Students should use their arrows to represent both the strength and direction of each force. The force of the wind/air from the fan pushes the cotton ball forward (or sideways) so it changes direction. The two objects touching are the cotton ball and the wind/air from the fan, not the fan itself. The wind exerts a pushing force that changes the direction of the cotton ball's motion.* | sized arrow and pointed it down because gravity pulled the cotton ball toward the ground. Gravity is a force that's always pulling things toward Earth. | |

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| | | | Finally, use the arrows to explain why the cotton ball continued falling downward and then stopped when it hit the ground.<br><br>**NOTE TO TEACHER:** *Students should once again use the arrows to represent both the strength and direction of each force. Gravity is still pulling the cotton ball downward. When the cotton ball reaches the ground, the force of friction between the floor and the cotton ball makes the cotton ball stop moving down and forward (or sideways).*<br><br>*For extra credit, encourage students to describe the forces acting on the cotton ball after it stops moving.*<br><br>• *Is gravity still pulling on the cotton ball? [Yes.]*<br>• *What force keeps the cotton ball from moving any farther toward Earth? [The force of the floor pushes up on the cotton ball with a force equal to the force of gravity, so the cotton ball doesn't move.]*<br><br>*Remind students that this example is similar to the pencil at rest on the table (lesson 5b). Equal but opposite forces are acting on both the pencil and the cotton ball and keep them from moving.* | | |

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| | | | **Show slide 10.**<br><br>The diagram on the slide shows the forces that were acting on the cotton ball. How does this description compare with your ideas?<br><br>**NOTE TO TEACHER:** *In addition to the diagram on the slide, you may also want to display figure 4 from the content background document. Compare the diagram(s) with students' ideas about the cotton ball's motion and the forces involved and address any student misconceptions and inaccuracies.* | | |
| 6 min | **Synthesize/Summarize Today's Lesson**<br><br>**Synopsis:** Students share how science ideas about forces helped them predict and describe the motion of a cotton ball dropped in front of a rotating fan.<br><br>**Main science idea(s):**<br>• *Forces* are pushes or 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 whether or not it will move and in what | Highlight key science ideas and focus question throughout.<br><br>Engage students in making connections by synthesizing and summarizing key science ideas. | **Show slide 11.**<br><br>Today we've been thinking about the focus question, *How can ideas about forces help us predict the motion of objects?*<br><br>**Think-Pair-Share:** What have you learned about forces in this unit that can help you predict the motion of objects? Think about this question for a moment; then share with a partner how knowing about forces helped you predict and describe the motion of a cotton ball in front of a rotating fan.<br><br>**NOTE TO TEACHER:** *Circulate around the room during this sharing activity. If students are struggling to describe how knowing about forces helped them with their predictions and descriptions in today's* | | |

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| | direction. | | *activity, ask questions that will help them express something similar to the ideal student response on the overview page:*<br><br>*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 whether or not it will move and in what direction.*<br><br>**Show slide 12.**<br><br>Let's review the key ideas on the slide that helped us answer today's focus question:<br><br>• *Forces* are pushes and pulls that can change an object's motion.<br>• If we know the strength (size) and direction of the forces acting on an object, we can predict whether or not it will move and in what direction. | Summarize key science ideas. | | |
| 1 min | **Link to Next Lesson**<br><br>**Synopsis:** The teacher announces that in the final lesson of the unit, students will show what they know by acting out forces and the motion of objects in real-life scenarios. | Make explicit links between science ideas and activities. | **Show slide 13.**<br><br>In our final lesson of this unit, you'll show what you know by acting out forces and the motion of objects in real-life scenarios.<br><br>We'll call you the Physics Players! | | |