Forces
Lesson 3b: Does the Surface Matter?

Grade 3	**Length of lesson:** 45 minutes	**Placement of lesson in unit:** 3b 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:** Why do moving objects slow down and eventually stop?
Main learning goal: Moving objects slow down and stop at different distances on different surfaces.		
Science content storyline: All moving objects on Earth eventually slow down and stop. The surface an object moves over determines how long it will take for the object to stop. Objects take longer to slow down and stop on smooth surfaces, but they slow down and stop more quickly on rough surfaces.		
Ideal student response to the focus question: The surface an object moves over or through has something to do with the object slowing down and stopping. Objects pushed with the same force travel farther over smooth surfaces than over bumpy surfaces.		

Preparation

Materials Needed

- Science notebooks
- Chart paper and markers
- *For surface investigation (1 setup per team):*
  - Wood strip (for ramp)
  - 1–2 wood blocks to support the ramp
  - Toy car (from lesson 2b)
  - Strip of carpet (4 ft long)
  - Strip of tile (4 ft long) with smooth surface (or 4 individual tiles)
  - Strip of sandpaper (4 ft long; glued to underside of tile)
  - Meter stick

Student Handouts

- 3.1 Does the Surface Matter? (Pages 2–3) (1 per student)

Ahead of Time

- Review section 3 (Friction) in the content background document.
- Glue the sandpaper to the underside of each strip of tile.
- Assemble surface-investigation materials for each team and place them on a tray or in a plastic container.
- On chart paper, create a class data table for teams to record the middle distance the car traveled over the carpet, the tile, and the sandpaper. (Use the table on page 2 of the handout as a model.)
- **ELL support:** Before the surface investigation, go over the procedure with ELL students and answer any questions they may have. Make sure they understand the purpose of the investigation and what they'll be doing.

Lesson 3b General Outline

Time	Phase of Lesson	How the Science Content Storyline Develops
4 min	**Link to previous lesson:** Students share their revised sentences from the previous lesson.	
1 min	**Lesson focus question:** The teacher reviews the focus question from the previous lesson: *Why do moving objects slow down and eventually stop?*	
9 min	**Setup for activity:** The teacher goes over the instructions for the surface investigation and explains how teams will collect and record their data.	• The surface an object moves over or through has something to do with the object slowing down and stopping.
15 min	**Activity:** Teams collect data on the distance a toy car travels over three different surfaces before stopping. Then students record the data on their handouts and a class data table.	• Objects pushed with the same force travel farther over smooth surfaces than over rough surfaces.
10 min	**Follow-up to activity:** Students look for patterns in the class data and make claims using the evidence they collected to explain why the car slowed down and stopped at different distances on different surfaces.	• Differences in surface texture must have something to do with variations in the distance an object moves when the same force is applied.
5 min	**Synthesize/summarize today's lesson:** Students complete a summary statement explaining why they think forces may or may not have something to do with stopping an object's motion. The teacher links this activity to the focus question.	• Forces are involved in making a moving object slow down and eventually stop.
1 min	**Link to next lesson:** The teacher asks students to elicit ideas from family members about one of the handout questions: *If forces make an object start to move, do they also have something to do with making an object stop moving?*	

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4 min	**Link to Previous Lesson** **Synopsis:** Students share their revised sentences from the previous lesson.	Highlight key science ideas and focus question throughout.	**Show slides 1 and 2.** In the previous lesson, we investigated the focus question, *Why do moving objects slow down and eventually stop?* At the end of the lesson you revised a sentence you completed earlier: *I think the soccer ball I kick on a field will eventually stop because _____.* Let's hear a few of your ideas. **NOTE TO TEACHER:** *Don't encourage any discussion of ideas at this point. Simply record them on chart paper to revisit later in the lesson. You might ask students to share how they completed this sentence the first time if there were any significant differences.*		
1 min	**Lesson Focus Question** **Synopsis:** The teacher reviews the focus question from the previous lesson: *Why do moving objects slow down and eventually stop?*	Set the purpose with a focus question or goal statement.	**Show slide 3.** Today we'll continue thinking about our focus question from last time, *Why do moving objects slow down and eventually stop?* You'll gather more ideas for answering this question from today's investigation.		

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9 min	**Setup for Activity** **Synopsis:** The teacher goes over the instructions for the surface investigation and explains how teams will collect and record their data. **Main science idea(s):** • The surface an object moves over or through has something to do with the object slowing down and stopping.		**NOTE TO TEACHER:** *Distribute pages 2 and 3 of handout 3.1 (Does the Surface Matter?) and have students locate the first page they completed during the previous lesson.* In our previous lesson, you made some predictions about whether a toy car will travel the same distance across three different surfaces. Take out that first page of your handout now. **Show slides 4 and 5.** For today's investigation, you'll work in teams using the same materials from our demonstration last time: a ramp, a toy car, three different surfaces, and a meter stick to measure the distance the car travels across the surfaces. **NOTE TO TEACHER:** *Show students the tray or container of materials they'll use for the investigation.* Each team will set up these materials on the floor the way they're set up on the slide and the first page of your handout. **NOTE TO TEACHER:** *As you walk students through the steps they'll follow, demonstrate how to set up the ramp with the strip of carpet, replace it with the*		

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			strip of tiles, and then flip over the strip of tiles to set up the strip of sandpaper. First, you'll set up the ramp with the carpet right below the ramp. Lay the meter stick alongside the carpet with the 0 mark at the bottom of the ramp so it will be easy to read. Don't pick up the meter stick. Leave it in place when you take your measurements. When you measure the distance the car traveled over the carpet, make sure to measure from the end of the ramp to the *front* of the car. After you finish measuring the distance and recording your data, you'll switch out the strip of carpet with the strip of tile and repeat the steps on the handout. When you finish recording your data for the tile, you'll turn the strip over to set up the sandpaper and repeat the test. Remember, to start the car moving, place it at the top of the ramp. Don't push the car; just set it *gently* at the top and let it go. The force of gravity will pull it toward the ground. **Show slide 6.** Now let's read through the data-		

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			collection instructions for step 2 on your handouts. **NOTE TO TEACHER:** *Alternatively, you could have students read the instructions independently or with a partner. After reading the instructions on the handout, review them to make sure students understand what to do and where to record their data. As needed, demonstrate how to measure distances accurately and how to compare the distance measurements from the three trials and determine the middle distance.* So how many trials will you conduct with each surface? How will you measure the distance for each trial? Where will you record your results? What does it mean to record the middle distance? What is the middle distance?	Three. We'll use the meter stick to measure from the bottom of the ramp to the front of the car. On the data table on the handout. The middle distance is the distance between the other two distance measurements.	

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			Why do you think you need to conduct three trials and record the middle distance? Why might a scientist do an experiment more than once? **NOTE TO TEACHER:** *Have a brief discussion about why multiple trials are important in scientific investigations if you haven't had this discussion before. Help students understand why the middle distance might be the more accurate number if they aren't familiar with averages.* **ELL support:** Preview what an experiment is, or a fair test. **Show slide 7.** When you finish your investigation, one member from each time will record on a class data table the middle distance for each of surface. **NOTE TO TEACHER:** *Show students where they'll record their data on the class data table.*	That's the one we'll record. Maybe we need to try more than once to get it right. So we get the right measurement. We need more than one trial to find out if the car rolls about the same distance each time. The middle number is the average of all the trials.	Say more about getting it right. Can someone add to this idea? Tell us why that matters. And what do we already know about taking an average?

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		Highlight key science ideas and focus question throughout. Make explicit links between science ideas and activity **before** the activity.	Keep our focus question in mind during the investigation. We're trying to figure out why moving objects slow down and eventually stop. OK, any questions before we begin? **NOTE TO TEACHER:** *After answering any final questions, divide the class into teams and have one member of each team come up and get a tray or container of materials. Then assign each team an area on the floor to carry out their investigation.*		
15 min	**Activity** **Synopsis:** Teams collect data on the distance a toy car travels over three different surfaces before stopping. Then students record the data on their handouts and a class data table. **Main science idea(s):** • Objects pushed with the same force travel farther over smooth surfaces than over rough surfaces.	Select content representations and models matched to the learning goal and engage students in their use.	OK, I'd like each team to move to your assigned spot on the floor. Bring your pencils and handouts with you. Choose one team member to set the car in place at the top of the ramp and another team member to measure the distance the car travels over the surface for each trial. If you're the one measuring the distance, make sure to give this information to the rest of the team so everyone can record it on their data tables in the handout. Take turns with these roles. You'll have 10 minutes to conduct all nine trials, measure the distances, and record the measurements on your data tables.		

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		Ask questions to elicit student ideas and predictions? Ask probe questions to elicit student ideas and predictions.	When your team has finished the investigation, please place your materials back on the table, return to your seats. Then have one team member record your middle distances on the class data table. Team representatives should come up and record their data on the table one at a time. **NOTE TO TEACHER:** *Circulate among the teams as they conduct their trials and collect data. Remind them to carefully follow the directions on the handout, measure accurately, and record their data on the table under the correct headings. Ask questions that help students stay focused on the science ideas in the lesson. Examples:* • *How far did the car travel on the carpet compared to the sandpaper? Does that match your prediction?* • *On which surface did you think the car would travel the farthest or the shortest distance? Is that what happened?* **ELL support:** When ELL students answer your questions, listen carefully and write down responses that are confusing, surprising, or useful for a whole-class discussion with multiple perspectives.		

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			NOTE TO TEACHER: *As teams wrap up their investigations, remind them to complete steps 3 and 4 on their handouts. Assist students who need help recording the middle distances on the class data table.*		
10 min	**Follow-Up to Activity** **Synopsis:** Students look for patterns in the class data and make claims using the evidence they collected to explain why the car slowed down and stopped at different distances on different surfaces. **Main science idea(s):** • Differences in surface texture must have something to do with variations in the distance an object moves when the same force is applied.	Engage students in analyzing and interpreting data and observations.	**Show slide 8.** Let's try to make sense of our data by examining the class table. What patterns do you see in the data? **ELL support:** ELL students benefit from explicit instructions so they know what's expected of them. Provide clear and explicit descriptions of what a pattern is and where they might find patterns in the table. Can you identify any other patterns?	The tile always went the farthest. I mean the car went the farthest on the tile surface. The distance on the sandpaper is mostly in the middle. The car always went the shortest distance on the carpet.	What do you mean by "the tile always went the farthest"? Say more about "mostly in the middle." Can you use some numbers from the data table to support your idea? What about the

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		Engage students in constructing explanations and arguments.	Do these results match the predictions you wrote on page 1 of your handout? Give me a quick show of hands. How many of you predicted the car would roll the greatest distance on the tile surface and the shortest distance on the carpet? **Show slide 9.** Now let's answer the questions in step 5 of our handout. Question 1 asks, *Why do you think the car traveled different distances over the three surfaces?* Write your explanations on your handouts and make sure to support your ideas with evidence from the data table and our investigation. **ELL support:** Allow ELL students to talk about the question with shared-language partners for 1 or 2 minutes. Verbalizing their ideas will help students articulate them in writing.		carpet? What can you say about the pattern of distances we recorded for the carpet?

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		Engage students in communicating in scientific ways.	**NOTE TO TEACHER:** *Give students 1 or 2 minutes to write their answers to question 1. If time allows, have them share their ideas with a partner before sharing them with the class. This might encourage more participation in the class discussion.* **Whole-class discussion:** Why do you think the car traveled different distances over different surfaces in this investigation? Make sure to include evidence from the data table. STOP Listen to students' ideas. What's visible about student thinking? **NOTE TO TEACHER:** *Allow students to share their ideas about what caused the different results. If time allows, engage students in communicating in scientific ways for about 5 minutes, especially if they express some of the inaccurate ideas that appear in column 5 or the Common Student Ideas resource document in the lesson plans binder. If there isn't enough time to address student misconceptions or confusion, jot down ideas you might want to address in a future lesson or class discussion.* **ELL support:** Be explicit about what it means to communicate in scientific ways	The car went a lot farther on the tile surface. The tile is the smoothest and slickest surface. Well, the sandpaper has these little bumps on it. It isn't smooth like the tile.	Why do you think that is? What's different about the tile compared to the other surfaces? How would you describe the sandpaper? Do you think that has something to do with why the car traveled a middle distance on the sandpaper?

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			and model this for ELL students. If it means providing evidence in a specific instance, model this as well.	Yes. You could tell that the car was bumping along as it went over the sandpaper. I think that made it stop sooner. It was like the carpet tried to stop the car. Like the bits of carpet reached up and grabbed it. When the car hit the carpet, the little fibers that make the carpet fuzzy hit the car and it stopped. I think the car traveled the farthest on the tile because it's easier to roll over the smooth surface, and harder to roll over the	Why do you think the car traveled such a short distance over the carpet? What do you mean the carpet "reached up and grabbed" the car? Is that possible?

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				bumpy surface. I think it's because some surfaces are hard and some are soft. *[Inaccurate]* The carpet is the softest surface, and the tile is the hardest. But the sandpaper is pretty hard too. *[Inaccurate]* I think it's because the force must soak into some surfaces more than others. It doesn't soak into the tile, so the car goes farther.	What do you mean by "it's easier to roll over the smooth surface"? Why would one surface be easier or more difficult for the car to roll over than the others? Which surfaces would you say are hard, and which ones are soft? Why do you think that would make a difference?

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				[Misconception] I think that if the car went different distances on the three surfaces, there must have been a different force each time. *[Misconception.]* In our last lesson, we said that gravity was the force that pulled the car down the ramp. I guess the car had the same force each time, unless someone pushed on it at the top of the ramp.	What do you mean by "the force must soak into some surfaces"? How does it do that? Say more about a "different force." Does someone want to add to this idea? Was gravity pulling any differently each time the car went down the ramp?

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5 min	**Synthesize/Summarize Today's Lesson** **Synopsis:** Students complete a summary statement explaining why they think forces may or may not have something to do with stopping an object's motion. The teacher links this activity to the focus question. **Main science idea(s):** • Forces are involved in making a moving object slow down and eventually stop.	Engage students in making connections by synthesizing and summarizing key science ideas. Highlight key science ideas and focus question throughout.	**Show slide 10.** We have some good initial ideas to explain why the toy car traveled different distances over the three surfaces. Keep these ideas in mind as you think about the final question on your handouts: *If forces make an object start to move, do they also have something to do with making an object stop moving?* **Turn and Talk:** Discuss this question with a partner and then complete the sentence on the handout: *I think forces [do/do not] have something to do with making an object stop moving because _____.* Make sure to explain your answers using evidence from your investigation. Be prepared to share your ideas with the class at the beginning of our next lesson. **Show slide 11.** Over the last two lessons, we've been exploring the focus question, *Why do moving objects slow down and eventually stop?*		

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			How would you answer that question now based on today's investigation?		
1 min	**Link to Next Lesson** **Synopsis:** The teacher asks students to elicit ideas from family members about one of the handout questions: *If forces make an object start to move, do they also have something to do with making an object stop moving?*		**Show slide 12.** Next time, we'll continue thinking about why objects slow down and eventually stop. At home tonight, find out how your family members would answer the last question on our handout: *If forces make an object start to move, do they also have something to do with making an object stop moving?* Make sure to ask them why.		