Earth's Changing Surface
Lesson 3b: Plate Movement and Mountain Building

Grade 4	**Length of lesson:** 48 minutes	**Placement of lesson in unit:** 3b of 7 two-part lessons on Earth's changing surface
Unit central questions: Why isn't all of Earth's surface flat? What causes the surface to look different in different places?		**Lesson focus questions:** Are the moving plates of Earth's crust involved in building up Earth's surface and forming mountains? If so, how?
Main learning goal: Earth's tectonic plates move in different directions. They can move toward each other (collide), move away from each other, or move side to side. Plate collisions cause Earth's surface to build up, forming mountains and other surface features. Mountains can also form as a result of repeated volcanic eruptions.		
Science content storyline: Earth's thin outer layer (crust) of cold, rigid rock is made up of interlocking plates, like puzzle pieces, that scientists call *tectonic plates*. These plates float on a thick layer of hot, slowly moving rock underneath. Heat from Earth's core softens this underlying layer of rock, causing it to rise toward the surface. This movement causes the rigid plates of Earth's crust to move in different directions. When the plates move toward each other and collide, the crust crunches together and piles up. As this happens slowly over time, mountains are formed on Earth's surface. Mountains can also form as a result of repeated volcanic eruptions that build up Earth's surface layer by layer. The hot, slow-moving rock inside Earth causes both plate collision and volcanic mountain building.		
Ideal student response to the focus questions: Earth's plates don't all move in the same direction. When two plates crash into each other, the land gets all wrinkled up like the graham crackers we looked at. These wrinkles are like mountain ranges on Earth's surface.		

Preparation

Materials Needed • Student notebooks • Chart paper and markers • Foam mats (from lesson 3a) • Construction-paper arrows (cutouts from lesson 3a) **Student Handouts and Teacher Masters** • 3.2 How Earth's Plates Move (1 per student) • 3.3 How Earth's Plates Move (Teacher Master) (for display) • 3.4 Graham-Cracker Collision (Teacher Master) (for display)	**Ahead of Time** • Review Earth's Changing Surface Content Background Document: sections 4–6. • Prepare handouts 3.3 (How Earth's Plates Move) and 3.4 (Graham-Cracker Collision) for display on a document reader or Smart Board.

Lesson 3b General Outline

Time	Phase of Lesson	How the Science Content Storyline Develops
3 min	**Link to previous lesson:** Students review what they learned from the foam-mat model in the previous lesson about the movement of Earth's tectonic plates.	• Earth's tectonic plates float on a layer of hot, slowly moving rock that causes them to move in different directions. Consequently, Earth's plates can move in three basic ways: (1) toward each other, (2) away from each other, and (3) side to side.
4 min	**Lesson focus questions:** The teacher reviews the focus questions from the previous lesson: *Are the moving plates of Earth's crust involved in building up Earth's surface and forming mountains? If so, how?*	
5 min	**Setup for activity:** The teacher introduces scientists' discoveries about the movement of Earth's tectonic plates.	• Evidence from scientific investigations support our ideas that Earth's tectonic plates move in three basic ways: (1) They move toward each other (collide); (2) they move away from each other; and (3) they move side to side (slide past each other).
10 min	**Activity:** Students analyze two models—foam mats and graham crackers—and consider whether plate movements could result in mountains forming on Earth's surface.	• Earth's thin outer layer (crust) consists of tectonic plates that float on a thick layer of hot, slowly moving rock underneath. Heat from Earth's core softens this underlying layer of rock, causing it to rise toward the surface. This movement causes the rigid plates of Earth's crust to move in different directions—toward each other, away from each other, and side to side. When the plates move toward each other and collide, the crust crunches together and piles up. As this happens slowly over time, mountains are formed on Earth's surface.
10 min	**Follow-up to activity:** Students critique the foam-mat model and consider the amount of time involved in plate movement and mountain building.	• Tectonic plates collide as they move toward each other, causing Earth's crust to crunch together and pile up. As this happens slowly over time, mountains form on Earth's surface. Earth's plates move, on average, only 1 to 16 centimeters per year.
15 min	**Synthesize/summarize today's lesson:** Students write their ideas for answering the focus questions about how mountains form. Then they pair up and tackle a use-and-apply question that requires them to use what they've learned so far to predict what might happen when Earth's plates collide, move apart, or move side to side.	• Earth's tectonic plates can move toward each other (collide), move away from each other, move or side to side. Plate collisions can cause Earth's crust to crunch together and pile up. As this happens slowly over time, mountains form on Earth's surface. Mountains can also form when repeated volcanic eruptions build up Earth's surface layer by layer over time. Both plate collisions and volcanic mountain building involve hot, slow-moving rock within Earth's interior.
1 min	**Link to next lesson:** The teacher reviews science ideas from today's lesson and previews the next lesson.	

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3 min	**Link to Previous Lesson** **Synopsis:** Students review what they learned from the foam-mat model in the previous lesson about the movement of Earth's tectonic plates. **Main science idea(s):** • Earth's tectonic plates float on a layer of hot, slowly moving rock that causes them to move in different directions. Consequently, Earth's plates can move in three basic ways: (1) toward each other, (2) away from each other, and (3) side to side.	Engage students in making connections by synthesizing and summarizing key science ideas.	**Show slides 1 and 2.** In the previous lesson, we used foam mats and arrows to model how Earth's plates move. What did the foam mats represent in our model? What did the arrows represent? From our foam-mat model and the drawings we shared, what did we learn about how Earth's tectonic plates might move? What causes Earth's plates to move?	The foam mats were like Earth's tectonic plates. The arrows showed the direction Earth's plates can move. They can crash together. They can move apart and leave a big gap. They can slide side to side and move forward or backward. A layer of hot, slow-	How are the foam mats like Earth's plates? How are they different? What was our evidence of this movement?

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		Highlight key science ideas and focus question throughout.	Today, we'll find out what scientists have discovered about how Earth's crustal, or tectonic, plates move. We'll also think about the answer to our focus questions on mountain building. **Show slide 3.** As we investigate how Earth's crustal plates move, let's keep in mind one other key science idea from our last lesson: Earth's tectonic plates move because they're floating on a thick layer of hot, slow-moving rock underneath. Don't forget that the tables we laid our foam mats on last time represented this layer of hot, slow-moving rock.	moving rock underneath them.	
4 min	**Lesson Focus Questions** **Synopsis:** The teacher reviews the focus questions from the previous lesson: *Are the moving plates of Earth's crust involved in building up Earth's surface and forming mountains? If so, how?*	Set the purpose with a <u>focus question</u> or goal statement.	**Show slide 4.** Our focus questions for today are the same ones from the last lesson: *Are the moving plates of Earth's crust involved in building up Earth's surface and forming mountains? If so, how?* **ELL support:** In light of the previous plate investigation, you might consider focusing on the second question and rephrasing it: *How are Earth's crustal plates involved in building up Earth's surface and forming mountains?* Or as you ask the first question, emphasize mountain formation (e.g., *Are the moving*		

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			plates of Earth's crust involved in building up Earth's surface ***to form mountains****?*) So we're still thinking about how plate movement relates to mountain building on Earth's surface. Before we talk about what scientists have discovered about this, let's think about our foam-mat model of Earth's plates from last time. **Show slide 5.** **NOTE TO TEACHER:** *Distribute handout 3.2 (How Earth's Plates Move) and briefly review student ideas about plate movement from the previous lesson.* This handout shows three ideas we came up with about how Earth's plates might move. Next to each set of arrows on your handouts, write a short description of how plates move. **Individual work time (1 min).** **Whole-class share-out:** What are the three plate movements we came up with in our investigation? What did you write on your handouts to describe how Earth's plates might move?	Plates can move toward each other and crash into each other.	

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				Plates can move away from each other. Plates can move side to side and slide past each other.	
5 min	**Setup for Activity** **Synopsis:** The teacher introduces scientists' discoveries about the movement of Earth's tectonic plates. **Main science idea(s):** • Evidence from scientific investigations support our ideas that Earth's tectonic plates move in three basic ways: (1) They move toward each other (collide); (2) they move away from each other; and (3) they move side to side (slide past each other).	Make explicit links between science ideas and activities **before** the activity.	You've done a great job brainstorming different ways Earth's crustal, or tectonic, plates might move! Now let's see what scientists have discovered about how these plates actually move in the real world. **Show slide 6.** How do these plate movements compare with what you modeled in our last lesson? Yes! Scientific evidence shows that our ideas about plate movements are right. Plates can move toward each other and collide; they can move away from each other; and they can move side to side or slide past each other. In today's activity, we'll continue thinking about plate movement and mountain building and see if we can come to some conclusions.	We came up with the same ones the scientists discovered!	
10 min	**Activity**		**NOTE TO TEACHER:** *Display handout 3.3 (How Earth's Plates Move) on a*		

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	Synopsis: Students analyze two models—foam mats and graham crackers—and consider whether plate movements could result in mountains forming on Earth's surface. **Main science idea(s):** • Earth's thin outer layer (crust) consists of tectonic plates that float on a thick layer of hot, slowly moving rock underneath. Heat from Earth's core softens this underlying layer of rock, causing it to rise toward the surface. This movement causes the rigid plates of Earth's crust to move in different directions—toward each other, away from each other, and side to side. When the plates move toward each other and collide, the crust crunches together and piles up. As this happens slowly over time, mountains are formed on Earth's surface.	Engage students in analyzing and interpreting data and observations. Make explicit links between science ideas and activities **during** the activity. Engage students in communicating in scientific ways.	*document reader throughout this discussion.* **Show slide 7.** Do you think any of these plate movements are involved in forming mountains? **Turn and Talk (1–2 min):** Look at your answers to the focus questions from last time and then talk with a partner about whether you think plate movements form mountains. Be prepared to share your ideas with the class. **Whole-class discussion:** Let's hear your ideas. Do you think plate movements have anything to do with forming mountains? If so, use your foam mats and arrows to show how you think this happens. Be ready to agree, disagree, add an idea or suggestion, or ask questions. **Show slide 8.**	We think mountain ranges might form when Earth's plates crash together. We think mountain ranges form when the plates go over or under each other.	Show us with your foam mats why you think that. Show us with your foam mats why you think that.

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		Select content representations and models matched to the learning goal and engage students in their use. Ask questions to elicit student ideas and predictions.	So we think that when Earth's plates collide, mountain ranges build up. **NOTE TO TEACHER:** *Display handout 3.4 (Graham-Cracker Collision) on a document reader.* ***Show only page 1 ("Before the Collision") at this time****. The graham crackers in this image have been soaked briefly in water so they'll crumple up when they're pushed together.* **Show slide 9.** Let's look at another model of Earth's crustal, or tectonic, plates. Imagine that these graham crackers are two of Earth's plates. What do you predict will happen when these graham-cracker "plates" collide? What will they look like? Write your predictions in your science notebooks and draw a picture with labels. **Individual work time.** **Show slide 10.** **NOTE TO TEACHER:** *Display* ***page 2*** *of handout 3.4 (Graham-Cracker Collision) throughout the following discussion.* **Whole-class discussion:** So what happened to the graham crackers? Is this	The crackers got crumpled up.	

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			the result you predicted? How is this collision similar to or different from what happened when the foam mats collided? All of the folds or crumpled areas we see in the graham crackers are like mountain ranges, aren't they? What does this tell us about how mountains form?	I thought the crackers would break and not squish up like they did. The foam mats didn't have all the ridges like the graham crackers do. When the graham crackers collide, it looks more like little mountains. Mountains form when Earth's plates collide.	What do you mean by "ridges"?
10 min	**Follow-Up to Activity** **Synopsis:** Students critique the foam-mat model and consider the amount of time involved in plate movement and mountain building. **Main science idea(s):** • Tectonic plates collide as they move toward each other, causing Earth's crust to crunch together and pile up. As this	Engage students in constructing explanations and arguments.	**Show slide 11.** Think for a moment about our foam-mat model of Earth's crustal plates and then complete these sentences in your science notebooks: • *I think the foam mats are LIKE Earth's crustal plates because _____.* • *I think the foam mats are NOT LIKE Earth's crustal plates because _____.*		

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	happens slowly over time, mountains form on Earth's surface. Earth's plates move, on average, only 1 to 16 centimeters per year.	Link science ideas to other science ideas. Engage students in analyzing and interpreting data and observations. Highlight key science ideas and focus question throughout.	**NOTE TO TEACHER:** *If time allows, have students share their ideas with a partner in a Turn and Talk before the class share-out.* **Whole-class share-out:** What ideas did you come up with? In what ways are the foam mats like Earth's plates? In what ways are the mats not like Earth's plates? **Show slide 12.** One important way in which our foam-mat model is *not* like Earth has to do with *time*. How long did it take us to push our foam mats together to create a plate collision? How long do you think it takes Earth's	The mats move. They can change shape when they collide. Foam is different from rock. The foam mats are much smaller than Earth's plates. Plates float on top of hot, slow-moving rock, but we made the mats move using our hands. A few seconds.	

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			plates to move and collide to form mountains? **Show slide 13.** In contrast to our model, Earth's plates move anywhere from 1 to 16 *centimeters* a year. Can someone come up to the board and draw a line 1 centimeter long? Can someone else draw a line 16 centimeters long? Now try to imagine taking *a whole year* to move your foam mats just 1 centimeter. Can you demonstrate how slowly the mats would move? **Show slide 14.** So Earth's plates move very, very slowly. That's why we can't see mountains being built. It happens a tiny bit at a time over many years. **ELL support:** Reinforce the concept from lesson 2a of *gradual* changes taking place over a long period of time. To convey this concept visually, consider showing a video simulation of this process and discuss it to encourage ELL students to use developing vocabulary and language skills. When Earth's plates *do* move, what	A really long time. We can't move that slowly!	

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			happens? What are some examples? **ELL support:** Images might be helpful during this discussion. Even though Earth's plates can move in short spurts that we sometimes feel as an earthquake, mountain building is normally a very slow, gradual process. So when we say that plate collisions are like foam mats or graham crackers crashing into each other, we aren't taking into account the amount of time it actually takes to build a mountain. Think about how long it would take to build a mountain range with colliding foam mats or graham crackers. It would take a long, long time, wouldn't it?	Earthquakes. Volcanoes. Tsunamis and landslides.	
15 min	**Synthesize/Summarize Today's Lesson** **Synopsis:** Students write their ideas for answering the focus questions about how mountains form. Then they pair up and tackle a use-and-apply question that requires them to use what they've learned so far to predict what might happen when Earth's plates collide, move apart, or move side to side.	Engage students in using and applying new science ideas in a variety of ways and contexts.	**Show slide 15.** What do you think now about how mountains form? Using the sentence starter on the slide, write down your ideas in your science notebooks: *I think mountains are formed by _____.* **ELL support:** Have ELL students share their ideas with a partner before writing in their science notebooks.		

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	Main science idea(s): • Earth's tectonic plates can move toward each other (collide), move away from each other, or move side to side. Plate collisions can cause Earth's crust to crunch together and pile up. As this happens slowly over time, mountains form on Earth's surface. Mountains can also form when repeated volcanic eruptions build up Earth's surface layer by layer over time. Both plate collisions and volcanic mountain building involve hot, slow-moving rock within Earth's interior.	Highlight key science ideas and focus question throughout. Select content representations and models	**Whole-class share-out:** How did you complete the sentence on the slide? What do you think causes mountains to form? **NOTE TO TEACHER:** *Allow a few minutes for students to write down their ideas and then invite two or three students to share their ideas with the class.* **Show slide 16.** Today we continued our investigation of the focus questions from last time: *Are the moving plates of Earth's crust involved in building up Earth's surface and forming mountains? If so, how?* **Think-Pair-Share:** Look at the answers you wrote in your science notebooks at the end of the last lesson. How have your ideas changed after today's investigation? Think about this for a moment and then share with a partner. **Show slide 17.** *Embedded Assessment Task* Now I have a bubble challenge for you and your partner to think about. First, draw in your notebooks a bubble map like	Mountain ranges form where Earth's plates collide. Also, mountains can build up from volcanic eruptions. When Earth's plates crash into each other, the land gets crumpled up into mountain ranges.	

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		matched to the learning goal and engage students in their use. Ask questions to elicit student ideas and predictions.	the one on this slide. In the three central bubbles on the map, write the headings "Collide," "Move Apart," and "Move Side to Side." **Show slide 18.** Next, see if you and your partner can predict some of the things you might see or feel at each type of boundary between two tectonic plates. Are the movements at these boundaries the same or different? What might happen at all of the boundaries? What might happen at only one type of boundary? Write your predictions in the bubbles surrounding the boundary headings. **Individual work time (3–5 min).** **Whole-class share-out:** So what did you come up with? What do you predict you might see or feel at each boundary?	We think we might feel earthquakes. We think we would see volcanoes erupting. No, sometimes we might just see mountains.	Do you think you'd feel earthquakes at each type of boundary? Would you always see volcanoes erupting? Do you think we have

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				I'm not sure. I think that when the plates pull away from each other, there's a big hole, and lava comes through it.	mountains at each plate boundary? Does anyone else have any ideas? Can someone else add to that idea?
1 min	**Link to Next Lesson** **Synopsis:** The teacher reviews science ideas from today's lesson and previews the next lesson.	Summarize key science ideas. Link science ideas to other science	**Show slide 19.** So far we've discovered that Earth's surface is made up of tectonic, or crustal, plates that float on top of hot, slow-moving rock inside Earth. We think that mountains form where these plates collide. We also think that plate collisions sometimes cause earthquakes and volcanic eruptions. **ELL support:** A visual might be useful here by way of summary. It would be ideal to select a visual that can be displayed throughout the unit and used as a reference for everyone in future discussions. A good practice, in general, is to have key visuals (with labels and descriptions) posted in class as they arise in the lessons. **Show slide 20.** Next time, we'll see if we can find evidence to support the idea that		

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		ideas.	mountains form when Earth's crustal plates collide.		