

Earth's Changing Surface

Lesson 5a: Rocks Change over Time

Grade 4	Length of lesson: 40 minutes	Placement of lesson in unit: 5a 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: Can mountains grow so tall they reach outer space? Why or why not?
Main learning goal: <i>Weathering</i> is a process that changes Earth's surface by causing rock to fragment, crack, and crumble into smaller pieces.		
Science content storyline: Mountains on Earth never grow so tall that they reach outer space, because the rock that makes up mountains is continually broken into smaller pieces through a process called <i>weathering</i> . Although plate collision can cause the continual uplift of mountains, the height of a mountain is limited, in part, by weathering.		
Ideal student response to the focus questions: Mountains don't keep getting taller and taller forever, because the rock that forms them is always getting broken down into smaller pieces. Different things can break rock into smaller pieces. Tree and plant roots can grow in the cracks of a rock and break the rock apart. Water in a crack of a rock can expand when it freezes, making the crack get bigger and eventually break the rock apart. Rocks hitting other rocks when they fall or are carried away in fast-flowing streams can also cause rock to break. This breaking-apart process is called <i>weathering</i> .		


Preparation

<p>Materials Needed</p> <ul style="list-style-type: none"> • Science notebooks • Chart paper and markers • <i>For each group of 3–4 students (Task B):</i> <ul style="list-style-type: none"> • Cans of soda (2 cans per group—1 at room temperature and 1 frozen) <p>Student Handouts</p> <ul style="list-style-type: none"> • 5.1 Task Directions (1 per student or group) • 5.2 Pictures of a Tree in a Boulder (for Task A) (1 per group) 	<p>Ahead of Time</p> <ul style="list-style-type: none"> • Review Earth's Changing Surface Content Background Document: sections 7 and 8. • Prepare materials for Tasks A and B of the weathering investigation. • Place several cans of soda (1 per group and a few extra) in the freezer overnight. (Note: The frozen can of soda should show some expansion that causes the can to bulge or changes its shape in some other way.)
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Lesson 5a General Outline

Time	Phase of Lesson	How the Science Content Storyline Develops
3 min	Link to previous lesson: The teacher reviews science ideas from previous lessons and links them to today's lesson.	<ul style="list-style-type: none"> • Earth's thin outer layer (crust) is made up of interlocking tectonic plates that move slowly in different directions. Mountains form when these plates collide.
1 min	Lesson focus questions: The teacher introduces the focus questions, <i>Can mountains grow so tall they reach outer space? Why or why not?</i>	
10 min	Setup for activity: The teacher introduces two tasks that will help students answer the focus questions.	
10 min	Activity: In small groups, students complete two tasks that challenge them to think about processes that break apart and wear down mountains and other landforms on Earth's surface.	<ul style="list-style-type: none"> • Weathering causes rock to break into smaller and smaller pieces.
10 min	Follow-up to activity: The class discusses questions on the handout, and students suggest ways the two tasks are related.	<ul style="list-style-type: none"> • <i>Weathering</i> is a process that causes rock to fragment, crack, and crumble. As a result, rock is broken into smaller and smaller pieces.
5 min	Synthesize/summarize today's lesson: The teacher revisits the focus questions, and students synthesize science ideas from today's investigation.	<ul style="list-style-type: none"> • Although colliding tectonic plates can cause the continual uplift of mountains, the height of a mountain is limited, in part, by weathering. Weathering of rock happens in many different ways.
1 min	Link to next lesson: The teacher links science ideas to the next lesson.	

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3 min	<p>Link to Previous Lessons</p> <p>Synopsis: The teacher reviews science ideas from previous lessons and links them to today’s lesson.</p> <p>Main science idea(s):</p> <ul style="list-style-type: none"> • Earth’s thin outer layer (crust) is made up of interlocking tectonic plates that move slowly in different directions. Mountains form when these plates collide. 	Summarize key science ideas.	<p>Show slides 1 and 2.</p> <p>What have we discovered so far about how mountains form? What’s your evidence from past lessons?</p> <p>In previous lessons, we found out that the Earth’s crust is made up of interlocking tectonic plates that move very slowly in different directions.</p> <p>We also found out that when these plates collide, the surface of Earth builds up and forms mountains.</p>	<p>Mountains form from plates.</p> <p>When plates collide, they push up and form mountains.</p>	<p>What do you mean by “from plates”?</p> <p>Tell us more about plate collisions. How do you know this happens?</p> <p>What evidence do you have from past lessons?</p>
1 min	<p>Lesson Focus Question</p> <p>Synopsis: The teacher introduces the focus questions, <i>Can mountains grow so tall they reach outer space? Why or why not?</i></p>	Set the purpose with a <u>focus question</u> or goal statement.	<p>Show slide 3.</p> <p>Today we’re going to explore the focus questions, <i>Can mountains grow so tall they reach outer space? Why or why not?</i></p> <p>Write these questions in your science notebooks and draw a box around them.</p>		


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			<p>NOTE TO TEACHER: Write the focus questions on the board for students to see and refer to throughout the lesson.</p>		
10 min	<p>Setup for Activity</p> <p>Synopsis: The teacher introduces two tasks that will help students answer the focus questions.</p>	Ask questions to elicit student ideas and predictions.	<p>Show slide 4.</p> <p>Do you think that mountains can grow so tall they reach outer space?</p> <p>Think-Pair-Share: Think about this question for a moment; then complete the sentence on the slide in your science notebooks.</p> <p><i>I think mountains [can/cannot] reach outer space because _____.</i></p> <p>After writing down your ideas and reasons, talk about them with a partner. Be ready to share your ideas with the class.</p> <p>Whole-class share-out: So how did you complete the statement on the slide? Do you think mountains grow so tall they reach outer space? Why or why not?</p> <p> <i>During this discussion, listen for clues that students have previous understandings of weathering and erosion and the dynamic balance with mountain building. Do they have any misconceptions?</i></p>	<p>I've never heard of a mountain growing so tall it can reach outer space.</p> <p>I think the tallest mountain is Mount Everest, but it's not outer-space tall.</p>	How tall do you think the tallest mountains are?

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		<p>Make explicit links between science ideas and activities before the activity.</p>	<p>To find out whether mountains actually grow tall enough to reach outer space, let's do some investigating.</p> <p>For today's investigation, you'll split up into small groups and gather information that will help us answer our focus questions. These investigations will also help us think about what happens to rock on mountains and all over Earth.</p> <p>NOTE TO TEACHER: <i>Divide the class into groups of three or four students and distribute handout 5.1 (Task Directions) to each student (or group of students).</i></p> <p>Show slide 5.</p> <p>Each group will complete the first two tasks on the handout—Task A and Task B. Task C will be completed during the next lesson. In a moment, I'll give each group the materials and directions you'll need to complete these tasks.</p>	<p>Maybe the mountains just need more time to get taller. The San Gabriels are still getting built up.</p> <p>The map we saw showed that the plates are pushing together there.</p>	<p>Do you have evidence to support this idea?</p>

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		<p>Highlight key science ideas and focus question throughout.</p>	<p>NOTE TO TEACHER: <i>Alternatively, you could set up a materials center and appoint a materials manager from each group to pick up the necessary materials.</i></p> <p>But first, let’s go over the directions on the handout. Note that today’s focus questions appear at the top of the handout. Make sure to keep these questions in mind as you work on the tasks.</p> <p>Each task has a checklist that tells you what to do, followed by two questions to answer that are related to the task.</p> <p>NOTE TO TEACHER: <i>Briefly explain and/or model what students need to do for each of the tasks on the handout. Make sure to help students link the activity to the focus questions.</i></p> <p>As you finish each task, write your responses to the handout questions in your science notebooks using complete sentences.</p> <p>Remember, the goal of this investigation is to come up with ideas about whether mountains can keep growing taller and taller until they reach outer space.</p> <p>After completing each task, your group should (1) review the focus questions at the</p>		

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			top of the handout, (2) discuss any ideas the task gives you that help answer these questions, and (3) write these ideas in your science notebooks using complete sentences.		
10 min	<p>Activity</p> <p>Synopsis: In small groups, students complete two tasks that challenge them to think about processes that break apart and wear down mountains and other landforms on Earth’s surface.</p> <p>Main science idea(s):</p> <ul style="list-style-type: none"> Weathering causes rock to break into smaller and smaller pieces. 	<p>Select content representations and models matched to the learning goal and engage students in their use.</p> <p>Engage students in analyzing and interpreting data and observations.</p> <p>Ask questions to probe student ideas and predictions.</p>	<p>Show slide 6.</p> <p>Let’s begin our investigation with Task A. Make sure to follow the directions on the handout carefully.</p> <p>NOTE TO TEACHER: <i>Distribute one copy of handout 5.2 (Pictures of a Tree in a Boulder) to each group.</i></p> <p>Task A: For this task, you’ll observe two pictures of a tree growing in the crack of a boulder. These pictures of the same tree and boulder were taken in 1999 and 2014. Talk about any differences you observe between the pictures, focusing on the boulder and the tree. Then answer the questions in your science notebooks.</p> <p>As I walk around the room during the activity, feel free to ask questions if the directions seem unclear.</p> <p>NOTE TO TEACHER: <i>Circulate around the room as groups work on each task. Listen to student ideas, respond to any questions, and probe student thinking when appropriate. Keep asking students how the task helps them think about the focus</i></p>		<p><i>Probe question to ask:</i></p> <ul style="list-style-type: none"> Does this give you any ideas about our focus question—

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			<p><i>questions.</i></p> <p>Small groups work on Task A.</p> <p>Show slide 7.</p> <p>Task B: Next you'll observe two soda cans, one that's frozen and one that isn't. Talk about any differences you notice between the two cans and then answer the questions in your science notebooks.</p> <p>Small groups work on Task B.</p>		<p>whether mountains can keep getting taller and taller?</p>
10 min	<p>Follow-Up to Activity</p> <p>Synopsis: The class discusses questions on the handout, and students suggest ways the two tasks are related.</p> <p>Main science idea(s):</p> <ul style="list-style-type: none"> <i>Weathering</i> is a process that causes rock to fragment, crack, and crumble. As a result, rock is broken into smaller and smaller pieces. 	<p>Make explicit links between science ideas and activities after the activity.</p> <p>Engage students in communicating in scientific ways.</p>	<p>Show slide 8.</p> <p>Whole-class discussion: Now that you've completed these two tasks, let's hear your ideas and observations. What ideas did each task give you for answering our focus questions about mountains getting so tall they reach outer space?</p> <p>Next, we'll talk about your answers to the handout questions. Listen carefully as your classmates share their answers, and be ready to agree, disagree, ask questions, or add to someone else's idea.</p> <p>NOTE TO TEACHER: <i>If time allows, have students share their responses to both questions for each task on the handout. If time is limited, discuss only the last question for each task. The purpose of this discussion is to (1) highlight how natural processes</i></p>		

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		<p>Ask questions to probe student ideas and predictions.</p> <p>Ask questions to challenge student thinking.</p>	<p><i>can break down rock, and (2) relate these tasks to the focus questions.</i></p> <p>Task questions:</p> <p>Task A</p> <ol style="list-style-type: none"> 1. Describe what happened to the tree and the boulder between 1999 and 2014. 2. Predict what will happen to the boulder in another 50 years. Explain why you think so. <p>Task B</p> <ol style="list-style-type: none"> 1. Why was the frozen soda can deformed. What do you think will happen to the can when the soda inside thaws? 2. Describe what you think happens over time when water freezes and then thaws in a crack in a rock. <p> <i>As students share their ideas, make sure to ask probe questions before asking challenge questions to make sure you understand student thinking.</i></p> <p>How did you answer the questions for each task?</p> <p>Did you notice anything these tasks had in common?</p>	<p>Not really. One task was about a rock, and the other was about</p>	

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		Summarize key science ideas.	<p>Show slide 9.</p> <p>In today’s investigation, we observed that a tree growing in the crack of a rock can change the rock slowly over a long period of time. We also observed that frozen liquid can change the shape of a soda can, and we related this to water freezing in the crack of a rock changing the rock over time.</p>	<p>frozen soda in a can.</p> <p>One of the questions for Task B asked about frozen rocks.</p> <p>Water can freeze in the cracks of a rock.</p> <p>Water might push the rock apart just like the tree did to the rock.</p> <p>The frozen soda changed the shape of the can, so I guess that freezing might do the same thing to rock.</p>	<p>Can you say anything more?</p> <p>Did Task B have anything to do with rock?</p> <p>Can rock freeze?</p> <p>What might freezing water do to a rock?</p> <p>And what does freezing water do to the rock that is similar to the can of soda?</p>

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			Now let's see how these science ideas relate to our focus questions.		
5 min	<p>Synthesize/Summarize Today's Lesson</p> <p>Synopsis: The teacher revisits the focus questions, and students synthesize science ideas from today's investigation.</p> <p>Main science idea(s):</p> <ul style="list-style-type: none"> Although colliding tectonic plates can cause the continual uplift of mountains, the height of a mountain is limited, in part, by weathering. Weathering of rock happens in many different ways. 	<p>Highlight key ideas and focus question throughout.</p> <p>Engage students in making connections by synthesizing and summarizing key science ideas.</p>	<p>Show slide 10.</p> <p>So let's turn our attention back to our focus questions: <i>Can mountains grow so tall they reach outer space? Why or why not?</i></p> <p>Small groups: In your small group, brainstorm ideas about how the two tasks we completed today might help us answer these questions.</p> <p>Think about what we discovered from each task. How might this relate to what happens to rocks high up on a mountain?</p> <p>Try to think of any connections that can help us answer our focus questions.</p> <p>NOTE TO TEACHER: <i>Monitor these small-group discussions. After 2–3 minutes, have groups share out so students can hear a variety of ideas.</i></p> <p>Show slide 11.</p> <p>Whole-class share-out: First, let's revisit the statement you completed earlier:</p> <p><i>I think mountains [can/cannot] reach outer space because _____.</i></p>		

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		Engage students in communicating in scientific ways.	<p>Raise your hand if you think that mountains <i>can</i> reach outer space. Who thinks they <i>can't</i>?</p> <p>What are your reasons and evidence?</p> <p>Based on today's investigation, how have your ideas changed about mountains reaching outer space? What do you think now?</p> <p>As you share your ideas, I'll record them on chart paper so we can revisit them in our next lesson.</p> <p>NOTE TO TEACHER: <i>As time allows, invite students to comment on one another's ideas. Do they agree or disagree? Can they add to these ideas? Do they have any questions? Keep trying to steer students' ideas toward the focus question. What happens to rocks and mountains over time, and how do these processes affect the growth of mountains? The next lesson will help students connect these ideas to the concept of weathering.</i></p>	<p>I think trees keep mountains from growing because their roots break up the rocks somehow.</p> <p>In Arizona, it's really hot. I don't think water would freeze there, so do mountains just keep growing?</p> <p>My grandmother lives in Minnesota, and in the winter the ice makes cracks in her sidewalk. If ice does that to sidewalks, it can break up the rocks on mountains, and that's why mountains don't grow tall enough to reach outer space.</p>	<p>Say more about your ideas.</p> <p>That's an interesting idea. What do others think?</p>

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1 min	<p>Link to Next Lesson</p> <p>Synopsis: The teacher links science ideas to the next lesson.</p>	Link science ideas to other science ideas.	<p>Show slide 12.</p> <p>Today we explored the effects of tree roots and freezing water on rocks.</p> <p>We still need to gather more evidence to answer our focus questions, so next time, we'll complete another task and add to our chart of ideas about whether mountains can grow so tall that they reach outer space.</p>		