Plate Tectonics

Our Restless Planet

By Beth Geiger
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Correlation to Science Standards
For information on alignment to state science standards and NGSS, visit https://sallyridescience.com/learning-products/product-standards

Correlation to Common Core
Sally Ride Science’s Key Concepts and Cool Careers book series provide students with authentic literacy experiences aligned to Common Core in the areas of Reading (informational text), Writing, Speaking and Listening, and Language as outlined in Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects. Plate Tectonics: Our Restless Planet and the accompanying activities align to the following standards:

Reading Standards for Literacy in Science and Technical Subjects 6-12 (RST)
Grades 6-8
Key Ideas and Details
1. Cite specific textual evidence to support analysis of science and technical texts.
2. Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.

Craft and Structure
4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics.

Integration of Knowledge and Ideas
7. Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

Range of Reading and Level of Text Complexity
10. By the end of grade 8, read and comprehend science/technical texts in the grades 6-8 text complexity band independently and proficiently.

Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6-12 (WHST)
Grades 6-8
Text Types and Purposes
1. Write arguments focused on discipline-specific content. a.-e.
2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. b., d., f.

Production and Distribution of Writing
4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Research to Build and Present Knowledge
7. Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
8. Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.
9. Draw evidence from informational texts to support analysis, reflection, and research.
CORRELATION TO STANDARDS

Range of Writing
10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Speaking and Listening Standards 6-12 (SL)
Grades 6-8
Comprehension and Collaboration
1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6, grade 7, and grade 8 topics, texts, and issues, building on others’ ideas and expressing their own clearly. a.-d.

Presentation of Knowledge and Ideas
4. Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes; use appropriate eye contact, adequate volume, and clear pronunciation.
   Grade 6
   Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation. Grade 7
   Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. Grade 8

Language Standards 6-12 (L)
Grades 6-8
Vocabulary Acquisition and Use
4. Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade 6, grade 7, and grade 8 reading and content, choosing flexibly from a range of strategies. a.-d.
6. Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases; gather vocabulary knowledge when considering a word or phrase important to comprehension or expression.

*Book pages pictured in the Teacher Guides are from eBook editions. Some pages in the print books have different images or layouts.

Cool Careers

Cool Careers in Biotechnology
Cool Careers in Earth Sciences
Cool Careers in Engineering (Upper Elementary)
Cool Careers in Engineering (Middle School)
Cool Careers in Environmental Sciences (Upper Elementary)
Cool Careers in Environmental Sciences (Middle School)

Cool Careers in Green Chemistry
Cool Careers in Information Sciences
Cool Careers in Math
Cool Careers in Medical Sciences
Cool Careers in Physics
Cool Careers in Space Sciences

Key Concepts in Science

Adaptations
Biodiversity
The Biosphere
Cells
Earth’s Air
Earth’s Climate
Earth’s Energy
Earth’s Natural Resources
Earth’s Water
Elements and Compounds
Energy Basics
Energy Transformations

Flowering Plants
Food Webs
Forces
Genetics
Geologic Time
Gravity
Heat
Life Cycles
Light
Motion
Organic Molecules
Photosynthesis and Respiration

Physical Properties of Matter
Plant and Animal Systems
Plate Tectonics
The Rock Cycle
Solids, Liquids, and Gases
Sound
Space Exploration
Sun, Earth, and Moon
Units of Measurement
Vertebrates
The Water Cycle
Weathering and Erosion

Sally Ride Science provides professional development and classroom tools to build students’ passion for STEM fields and careers. Founded by Dr. Sally Ride, America’s first woman in space, the company brings science to life for upper-elementary and middle school students.

Visit us at SALLYRIDESCIENCE.COM for more information.
Plate Tectonics: Earth’s Remarkable Past guides students as they explore how the forces of plate tectonics constantly reshape our planet’s surface. Students learn that Earth’s crust is broken up into large plates that move about on the mantle, the layer beneath the crust. They read about how geologists analyzed many clues to confirm the theory of plate tectonics. Students also learn about the three types of plate boundaries and the landforms that can result at these boundaries. Students discover how earthquakes and volcanoes are related to plate tectonics. At the end of each two-page spread, a brief statement called The Bottom Line sums up the key ideas about plate tectonics covered in those pages.

In Your World piques students’ interest in plate tectonics by pointing out that the ground beneath our feet is in constant motion. This idea sets the stage for the chapters that follow by getting students to think about the effects of plate tectonics on our planet—effects that are slow and subtle as well as sudden and dramatic.

Chapter 1 explains that Earth’s crust is broken into about a dozen large tectonic plates. Students learn that part of the evidence for plate tectonics comes from matching up coastlines where two continents once were joined, and identifying similar fossils and rock formations on those continents. Students also learn how the discovery of seafloor spreading supported the idea that Earth’s tectonic plates are on the move. The chapter also shows how plate tectonics has changed the shapes and locations of the continents and oceans over Earth’s long history.

Chapter 2 begins by introducing students to the driving force of plate tectonics—convection. Students learn how new crust forms where plates spread apart and how old crust is recycled where plates collide. The chapter vividly describes what happens where plates meet—how they move apart or collide, and how one plate may force the other down, or two plates may slide past each other.

Thinking Like a Scientist shows how scientists were able to support the idea of seafloor spreading by studying evidence of magnetic field reversals “frozen” in the ocean floor near the Mid-Atlantic Ridge. Students answer questions to reinforce their understanding of seafloor spreading.

Chapter 3 explains how plate movements cause stress to build up in Earth’s crust, and how that stress is released as an earthquake. Students also explore volcanoes and learn why most of Earth’s volcanoes, as well as earthquakes, are along plate boundaries, especially the edges of the Pacific Plate, a region known as the Ring of Fire.

How Do We Know? focuses on Lucy Jones, a seismologist whose work helps people better prepare for earthquakes. In Invention Connection, students are asked to identify their sources of water, gas, electricity, and phone service, and think about how to prepare for a natural disaster.

Hey, I Know That! allows students to assess their own learning through a variety of assessment tasks about the key concepts covered in Plate Tectonics.
Preview the book

Ask students to browse through Plate Tectonics. Encourage them to look at the cover, table of contents, chapter titles, special features, photographs, and diagrams. Explain that paying attention to these features will give them clues about the text.

Read In Your World (pages 4 and 5) and discuss key concepts

Tell students to read In Your World. When they are finished reading, ask a student to show the class how far “a few centimeters” is by spreading his or her thumb and forefinger about 3 centimeters apart.

Correct students’ perception of this short distance if necessary, using a metric ruler. Remind students that this is the distance the ground beneath them moves, on average, each year. Then ask,

Why do you think we are usually unable to feel the Earth’s movement? [The movement happens too slowly and gradually for us to notice.]

When might we actually notice the movement? [You might feel the movement during an earthquake.]

Point out the underlined word crust on page 5. Ask,

What do you think of when you hear the word crust? [Sample answers: A crust is the outer part of bread or pie; it is a thin, flaky outer covering; it is often brittle.]

Write students’ responses on the board. Then circle key words that apply to the definition of crust as it relates to Earth’s structure. [outer part, thin, brittle] As you circle the words, say,

In some ways, the crust of bread or pie is like the crust of Earth. It’s the outer part of our planet. Earth’s crust is thin compared to Earth’s radius, and it’s relatively brittle; that is, it breaks when enough pressure is put on it.

Tell students that many scientific words are the same as words used in everyday language and that they have different but related meanings. Say that other such words are coming up in this book. Students can understand the words better by relating the scientific meanings to the common meanings of the words.

ADDRESS MISCONCEPTIONS

Students may think that, while tectonic plates move slowly, you still are able to observe this movement. To help students comprehend the slowness with which plates move, relate the movement to the speed at which their fingernails or hair grow. Ask, Are you able to see your hair or fingernails grow? [no] Are you able to observe the effects of this growth over a longer period of time? [yes] Explain that the movement of plates is similar. They move so slowly that we cannot see or feel them moving (except during an earthquake), but the cumulative effects of this movement become obvious over very long periods of time.
Read Chapter 1: *Plate Tectonics*

Before reading: Model making science vocabulary flash cards

Tell students that learning the vocabulary of a topic is an important part of understanding the topic. But emphasize that learning vocabulary is more than just memorizing definitions. Model learning science vocabulary by creating expanded vocabulary flash cards.

Begin by calling on a student to read loud page 6. Then point out the word *mantle*. Say,

*I want to make flash cards for any other words I think are particularly important. I’ll begin with mantle.*

On large index card, write *mantle*. Then say,

*From the text on this page, I have a good idea of what the mantle is. But I want to check it against the definition in the glossary.*

Turn to the glossary and read the definition for *mantle*: *the hot, partially molten layer of Earth between the core and the crust.* Then say,

*This definition makes sense, but I want to put it into my own words so I can remember it better. So on the card I’m going to write, The mantle is a layer of partly melted rock below Earth’s crust.*

*I’m also going to draw a diagram sort of like the one in the book showing Earth’s layers.*

Tell students they can also use the word in a sentence and write down the page number where the word is explained.

Ask students to create flash cards for key vocabulary terms in the *Plate Tectonics* book. As students read *Plate Tectonics*, provide time for them to quiz each other with the flash cards.

Read Chapter 1: *Our Dynamic Planet* (pages 6-11)

Ask students to read Chapter 1: *Our Dynamic Planet*. Give them the Chapter 1 handout and tell them to use it to take notes as they read. Point out that there is a space on the handout to make a concept map of key ideas in the chapter.

After reading: Discuss key concepts

Tell student to turn back to the beginning of Chapter 1. Read the title and subtitle, *Our Dynamic Planet: Plates on the Move*. Then ask,

*Why do you think the author chose the word dynamic for this title? Do you think it’s a good title?*

If students aren’t sure what *dynamic* means, tell them to consider what the chapter is about. *[The chapter is about the evidence for plate tectonics, which describes the motion of huge sections of Earth’s crust and the changes that motion causes.]* Prompt students to clarify their thinking by asking,

*What word could substitute for dynamic in the title?* *[Sample answer: The word changing could be used instead of dynamic.]*

Call on several students to share their ideas and discuss whether the title is fitting for the chapter.
Read Chapter 2: How Plates Move

Before reading: Model summarizing by making diagrams

Tell students that drawing diagrams is one way to summarize information as they read. Give students the handout for Chapter 2: How Plates Move and point out that it has a space to draw diagrams summarizing information in the chapter.

Have students turn to page 12. Call on a student to read the text aloud. Then draw students’ attention to the diagram, shown here. Say,

This page explains convection. I can see that convection is an important concept for understanding plate tectonics. But it’s sort of complicated. This diagram helps me visualize how the process works. I want to make a diagram in my notes. But I’m not an artist. How can I draw a simplified version of this convection diagram?

Call on students for ideas about making a simple diagram to show convection in Earth’s mantle. Then draw a diagram on the board and ask students to copy it on their handouts.

Read Chapter 2: How Plates Move (pages 12-17)

Ask students to read Chapter 2: How Plates Move, taking notes on their handouts as they read. In addition to completing their convection diagrams, they should draw a diagram for at least one other concept in the chapter, such as subduction.

After reading: Model tectonic plate interactions

Have students work in pairs. Hand out two index cards to each pair and ask them to use the cards to model some of the ways that plates interact with each other. Prompt students with these questions:

If I wanted to model seafloor spreading with my cards, how would that look? [The cards might rise up from between two desks pushed together. The cards would then move apart as they rise up from the crack.]

If I wanted to model subduction, what would I do? [To model subduction, you could push one card beneath the other as they collide.]

How would I model what’s happening in the Himalayas? [To model how the Himalayas are being pushed up, push the cards together and observe how both leading edges rise.]

How would I model what’s happening along the San Andreas Fault? [You could model plate movements along the fault by sliding one card past the other.]

Call on students to model each kind of tectonic plate movement and to explain their model.

Have students look back at the map of Earth’s tectonic plates on page 7. Then ask,

Based on what you have learned about tectonic plate movement, how do you predict the continents will move in the future?

Call on several students to share their ideas.
How Plates Move

The tectonic plates covered by oceans are dense but thin—as little as 5 kilometers (3.1 miles). Under the continents, plates are less dense but thicker—200 kilometers (124 miles) thick in places. When a dense ocean plate collides with a less dense continental plate, the ocean plate sinks, and the continental crust rides over it in a process called subduction. In a subduction collision, sediment may be scraped off of the ocean plate as it is forced down. Hills or mountains may be formed. The ocean crust beneath the sediment keeps moving down until it melts into Earth’s mantle. When two ocean plates collide, one forces the other down. This can create a trench in the ocean floor. When two continental plates collide, neither plate sinks. These head-to-head collisions can push up mountains. For example, the collision of the Australian-Indian Plate and the Eurasian Plate is pushing up the Himalayas.
Read *Thinking Like a Scientist* (pages 18-19) and answer the questions

Ask students to read *Thinking Like a Scientist*. Give them the *Thinking Like a Scientist* handout and have them use it to answer the questions on page 19. Have students work in small groups to discuss the questions and come to an agreement on the answers. Then ask each group to present to the class—members of each group should go through one question and show how they arrived at their answer.

Analyzing

As magma oozes out of the Mid-Atlantic Ridge, it makes new ocean floor. Geologists realized that this new floor was pushing older crust out of the way on both sides of the ridge, making the Atlantic Ocean wider. That meant that the continents were moving apart. *Aha!* The magnetic stripes confirmed plate tectonics. Eventually geologists discovered similar stripes all around Earth, anywhere magma oozes from a mid-ocean ridge.

Use the illustration of the Mid-Atlantic Ridge to answer these questions.

**ANSWER KEY**

1. How are the magnetic stripes like matching fingerprints? *The pattern and width of the stripes on the east side of the Mid-Atlantic Ridge match those of the stripes on the west side of the ridge.*

2. Which color stripe represents the oldest rocks? *The lightest orange rock and the white rock at the far left and far right of the diagram represent the oldest rock. This is the rock that has spread the farthest from the Mid-Atlantic Ridge, where magma is oozing out and forming new seafloor.*

3. Which color stripe represents the youngest rocks? *The youngest rocks are represented by the dark orange stripes in the middle of the diagram. This is the area of the ocean floor that formed most recently from magma oozing out of the Mid-Atlantic Ridge.*

4. Where are the youngest rocks? *The youngest rocks are immediately adjacent to the Mid-Atlantic Ridge.*
Read Chapter 3: *Earthquakes and Volcanoes*

**Before reading: Model summarizing with a cause-and-effect chart**

Before students read Chapter 3, model how to make a cause-and-effect chart of some of the concepts they learned in the first two chapters of *Plate Tectonics*. Say,

*Let’s organize what you’ve learned so far about plate tectonics. A lot of the information about plate tectonics is cause and effect—something causes something else to happen. So a good way to organize that information is to make a cause-and-effect chart.*

Draw a three-column chart, with the left column labeled *Cause*, the right column labeled *Effect*, and a right-facing arrow in the middle column. Say,

*I know that tectonic plates move, so in the Effect column, I am going to write, Tectonic plates move. I also know this movement is caused by convection currents in the mantle, so in the Cause column, I am going to write, Convection currents in the mantle move liquid rock in a circular motion.*

Then explain,

*Usually an effect becomes the cause of something else. For example, the movement of tectonic plates causes the continents to move. So for my next cause, I’ll write, Tectonic plates move. The effect is, Continents move. In this way, we can string together a lot of causes and effects.*

Continue building the cause-and-effect chart with these entries:

*Continents move → Continents collide*

*Continents collide → Land crumples and forms mountains*

Point out that this is only one possible string of causes and effects. For example, *Tectonic plates move* can also be the cause for *Subduction* and *Plates sliding past each other.*

**Read Chapter 3: *Earthquakes and Volcanoes* (pages 20-25)**

Ask students to read Chapter 3: *Earthquakes and Volcanoes*. Give them the Chapter 3 handout and tell them to take notes on it as they read. Also point out that there is a space on the handout to make a cause-and-effect chart of some of the concepts in Chapter 3.

**After reading: Discuss key concepts**

To check students’ comprehension of key ideas in Chapter 3, start a class discussion about some of the causes and effects described in the chapter. Ask,

*What causes a volcano?* [Volcanic eruptions can be caused when one tectonic plate is pushed down by another plate in a process called subduction. The crust is pushed so deep that it melts. The melted rock, or magma, erupts onto the surface as lava. Volcanic eruptions also can be caused by plates spreading apart. As plates spread apart, magma ooze to the surface as lava.]

*What are some of the effects of a volcanic eruption?* [A volcanic eruption can bury buildings or forests around the volcano. It can also send fumes and ash into the air. Over time, volcanic eruptions can build up mountain ranges.]
What causes an earthquake? [Earthquakes occur along fractures called faults. When the crust slips, the motion sends energy rippling through the crust. The released energy takes the form of seismic waves that spread out from the earthquake’s epicenter.]

What are some of the effects of an earthquake? [Large earthquakes can be very destructive. They can damage buildings and knock out roads and power lines. Earthquakes on the ocean floor can cause tsunamis.]

Call on students to share their ideas and to comment on each other’s ideas about the causes and effects of earthquakes and volcanoes.
Proving plate tectonics

Give students the Science Writing handout for Plate Tectonics. The handout asks students to write three paragraphs—each one describing a different type of evidence that supports the theory of plate tectonics.

**ANSWER KEY**

[Sample responses:

**Type of evidence: The shapes of the continents**

The shapes of the continents, especially South America and Africa, make them look as if they fit together like pieces of a puzzle. Scientists figured out that this was because hundreds of millions of years ago, the continents were all connected in one giant supercontinent, called Pangea. Because of plate tectonics, the continents gradually moved apart into the positions we know today.

**Type of evidence: Fossils and rock formations**

Fossils from the same extinct species and similar rock formations have been found on continents separated by huge oceans. For example, fossils of a reptile called Mesosaurus were found in both South Africa and Brazil. This fossil evidence supports the idea that the two continents were connected before plate tectonics caused them slowly to move apart.

**Type of evidence: Seafloor spreading**

The ocean floor is relatively thin and young, especially near mid-ocean ridges, where new crust is constantly being made. This means Earth’s crust is constantly being recycled. This recycling happens because Earth’s crust is always moving. So seafloor spreading is evidence of plate tectonics.

**Type of evidence: Locations of earthquakes and volcanoes**

Scientists noticed that the locations of earthquakes and volcanoes form a pattern. They occur at plate boundaries or where plates are moving over hot spots in the mantle. One example is the Ring of Fire—the circle of volcanic and seismic activity ringing the Pacific Ocean. This is evidence that movements of tectonic plates are causing earthquakes and volcanoes.]

**SCIENCE BACKGROUND**

It wasn’t until the 1960s that scientists began to accept the theory of plate tectonics. Before then, people assumed that the continents had always been in the same locations they are in today. However, as new evidence was discovered and presented, the scientific community began to change its thinking. This process of presenting new information and evidence and adapting or changing scientific theories has played out in all of the scientific disciplines. Darwin’s Theory of Evolution and the Big Bang Theory are two other theories that came to be accepted as evidence was discovered and presented.
Read *How Do We Know?* (pages 26-29)

Give students the *How Do We Know?* handout for *Plate Tectonics*. Have them look at the questions on the handout for the first section, *The Issue* (page 26). Then have them read that section and answer the questions. Have them complete the rest of the sections (*The Expert*, page 27; *In the Field*, page 28; *Technology*, page 29) in the same way. Tell students to share their answers in pairs. Then go over each question as a class. Call on two or three students to share their answers to each question.

**ANSWER KEY**

1. What is the San Andreas Fault, and why is it so important?  *The San Andreas Fault is a break in Earth’s crust located in California where the Pacific and North American plates slide past each other. Stress from the scraping and grinding of the plates builds up here, and its sudden release causes earthquakes.*

2. Why was the California earthquake of 1879 not a catastrophe, even though its magnitude was 7.9?  *The damage from the earthquake was minimal because there weren’t very many people living in the region at the time.*

3. What does Lucy Jones focus on in her work, and why?  *Lucy creates earthquake simulations. The goal of earthquake simulations is to help scientists and other experts learn about the effects of earthquakes and how to better prepare for damaging ones.*

4. Why does Lucy Jones make the magnitude-7.8 simulated earthquake seem so real?  *Sample answer: In order to prepare for a real disaster, you have to practice as if the disaster were real. That way, when the disaster strikes, you can use your training to act quickly and correctly.*

5. What actions have people in California taken to help ensure safety during earthquakes?  *People have changed the way buildings are designed and built in Southern California to try to ensure that the buildings are stronger and able to withstand an earthquake without people being injured.*
Complete the *Invention Connection* activity

Give students the *Invention Connection* handout and ask them to complete the activity. The handout instructs students to make a drawing showing the sources of the electricity, gas, water, and cell phone service for their community. Students can ask family members and also do research on the Internet to identify these lifelines. The handout also asks students to make a plan to prepare for a disaster. Internet resources can also give students ideas for disaster preparedness.

*Invention Connection: Your Lifelines*

Look around your home and neighborhood. Make a drawing of your lifelines. Where do your electricity, gas, and water come from? Where is the nearest cell phone tower? If you’re stumped, ask a parent or older sibling for help. With a partner, brainstorm ways to prepare for an earthquake, hurricane, or tornado.

**ANSWER KEY**

[Students’ drawings should identify the sources of electricity, gas, water, and cell phone signals for their community. Point out to students that any of these resources can be interrupted during an emergency, such as an earthquake or storm. Discuss with students how to prepare for an interruption of these services during an emergency.]
Make a poster about a natural disaster

Give students the *Create a Science Poster* handout. Have pairs of students research a natural disaster involving an earthquake, volcano, or tsunami.

**Students can research one of these disasters or choose another event:**

- The Chilean earthquake on May 22, 1960
- The Alaska earthquake and tsunami on March 27, 1964
- The eruption of Mount St. Helens, Washington state, on May 18, 1980
- The eruption of Mount Pinatubo, The Philippines, on June 15, 1991
- The Indian Ocean earthquake and tsunami of Dec. 26, 2004
- The Japanese earthquake and tsunami on March 11, 2011

**Tell students their research should focus on:**

- what caused the disaster.
- what effects the disaster had on the area in which it occurred.
- how people in the area could have better prepared for the disaster.

Students will present their findings by creating a science poster. The poster should have a title, captions or labels, and photos or diagrams. The handout has a space for students to design their poster. Give them poster board and markers or colored pencils to create their final posters.
Complete the *Hey, I Know That!* study guide (page 30)

Give students the *Hey, I Know That!* handout and ask them to use it to answer the questions on page 30 of *Plate Tectonics*. Have pairs of students discuss their answers and note any misunderstandings they may have. Then have students share and refine their answers in small groups. Finally, have groups share their answers with the class and clarify any misunderstandings.

**ANSWER KEY**

1. Which city would be best to live in if you really want to avoid earthquakes? Why? (pages 6 and 7)
   a. Boston, Massachusetts
   b. Athens, Greece
   c. Tokyo, Japan
   d. Seattle, Washington
   
   *The correct answer is a. Boston, Massachusetts, would be the best place to live to avoid earthquakes because it is the farthest from any plate boundaries. Tokyo, Japan, and Seattle, Washington, are both on the Ring of Fire, the seismically active zone around the Pacific Ocean. Athens, Greece, is near where the Eurasian Plate and African Plate meet.*

2. Imagine that you are a geologist trying to measure how fast the San Andreas Fault is slipping. Where would you place two GPS receivers? How often would you measure their positions—one a week, once a month, or once a year? Why? (page 17)
   
   *You could place one GPS receiver on the east side of the San Andreas Fault and another directly across the fault on the west side. Measurements could be taken once a year, because the slip rate of the fault is too slow to detect in a week or even in a month. Geologists have determined that the Pacific Plate moves north only about 2 centimeters (less than 1 inch) a year.*

3. Which of these mountain ranges is not volcanic? (page 24)
   a. Cascades, North America
   b. Himalayas, Asia
   c. Andes, South America
   
   *The correct answer is b. The Himalayas are being pushed up by the collision of two tectonic plates. The Cascades in the Pacific Northwest and the Andes in South America were both formed at least partly by volcanic eruptions.*

4. Using this map of the Hawaiian Islands, write down
   a. the direction that the Pacific Plate is moving. *The Pacific Plate is moving northwest.*
   b. where the next Hawaiian Island will form. *The next island will form just to the southeast of the Big Island—the island of Hawaii—as the Pacific Plate keeps moving to the northwest above the hot spot in the Earth’s mantle that has formed the Islands.*
   c. the name of the oldest Hawaiian Island still above water. (page 25) *The oldest island is Kauai. It formed 3.8 million to 5.6 million years ago. The youngest island, Hawaii, started to form 0.7 million years ago.*
Our Dynamic Planet: Notes for Chapter 1

As you read Chapter 1, write down the most important information you come across. Resist the urge to write down everything that you read. Instead, focus on the big ideas, or gist, of what you are reading.

PLATES ON THE MOVE

____________________________________________________

____________________________________________________

____________________________________________________

ALL CRACKED UP

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____________________________________________________

____________________________________________________

SLOW BUT STEADY

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____________________________________________________

THE CASE OF THE MATCHING FOSSILS

____________________________________________________

____________________________________________________

____________________________________________________

AN OCEAN THAT SPREADS

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____________________________________________________

CATCHING THE ACTION

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____________________________________________________

____________________________________________________
PICTURE THIS
Review your notes for Chapter 1. Summarize your notes by developing a concept map that makes sense to you. You might start with a central circle labeled Plate Tectonics. Extending from this circle might be other circles describing the evidence that supports plate tectonics and some details about how plate tectonics works.

PUT IT ALL TOGETHER
Use your notes and concept map to help you identify and list the most important ideas—the key concepts—in Chapter 1.

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__________________________________________________________________________________________
How Plates Move: Notes for Chapter 2

As you read Chapter 2, write down the most important information you come across. Resist the urge to write down everything that you read. Instead, focus on the big ideas, or gist, of what you are reading.

BIG FORCES, BIG EFFECTS

SLOW-MOTION MAKEOVER

OUT WITH THE OLD

SPLITSVILLE

COLLISION COURSE

SLIP SLIDING
PICTURE THIS

Review your notes for Chapter 2. Draw diagrams illustrating two concepts in the chapter, such as convection and subduction. Include labels and captions with your diagrams.

PUT IT ALL TOGETHER

Use your notes and diagrams to help you identify and list the most important ideas—the key concepts—in Chapter 2.
Thinking Like a Scientist: Explore Seafloor Spreading

Read Thinking Like a Scientist on pages 18 and 19 of Plate Tectonics. Then use the information on those pages and in the diagram to answer the questions.

Analyzing

As magma oozes out of the Mid-Atlantic Ridge, it makes new ocean floor. Geologists realized that this new floor was pushing older crust out of the way on both sides of the ridge, making the Atlantic Ocean wider. That meant that the continents were moving apart. Aha! The magnetic stripes confirmed plate tectonics. Eventually geologists discovered similar stripes all around Earth, anywhere magma oozes from a mid-ocean ridge.

1. How are the magnetic stripes like matching fingerprints?

_______________________________________________________________________________________
_______________________________________________________________________________________
_______________________________________________________________________________________

2. Which color stripe represents the oldest rocks?

_______________________________________________________________________________________
_______________________________________________________________________________________
_______________________________________________________________________________________

3. Which color stripe represents the youngest rocks?

_______________________________________________________________________________________
_______________________________________________________________________________________
_______________________________________________________________________________________

4. Where are the youngest rocks?

_______________________________________________________________________________________
_______________________________________________________________________________________
Earth’s History: Notes for Chapter 3

As you read Chapter 3, write down the most important information you come across. Resist the urge to write down everything that you read. Instead, focus on the big ideas, or gist, of what you are reading.

ACTION AT THE EDGES

__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________

SHAKE, RATTLE, AND ROLL

__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________

SUPER SIZZLERS

__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________

VOLCANO TOUR

__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________

THE RING OF FIRE

__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________

READY, SET, GO!

__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________

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**PICTURE THIS**

Review your notes for Chapter 3. Summarize your notes by making a cause-and-effect chart for earthquakes and volcanoes.

<table>
<thead>
<tr>
<th>Cause</th>
<th>Effect</th>
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<tbody>
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</tbody>
</table>

**PUT IT ALL TOGETHER**

Use your notes and cause-and-effect chart to help you identify and list the most important ideas—the key concepts—in Chapter 3.

__________________________________________________________________________________________
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Science Writing:
Proving Plate Tectonics

To support the theory of plate tectonics, scientists use several different kinds of evidence. Write three paragraphs—each one describing a different type of evidence that supports the theory of plate tectonics.

Type of evidence: ________________________________________________________________
________________________________________________________________________________________
________________________________________________________________________________________
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Type of evidence: ________________________________________________________________
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Type of evidence: ________________________________________________________________
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How Do We Know? 
Bracing for the Big One

Review the questions below for each section of How Do We Know? Then read each section in the book and answer the questions.

THE ISSUE
1. What is the San Andreas Fault, and why is it so important?

_______________________________________________________________________________________
_______________________________________________________________________________________
_______________________________________________________________________________________

2. Why was the California earthquake of 1879 not a catastrophe, even though its magnitude was 7.9?

_______________________________________________________________________________________
_______________________________________________________________________________________
_______________________________________________________________________________________

THE EXPERT
3. What does Lucy Jones focus on in her work, and why?

_______________________________________________________________________________________
_______________________________________________________________________________________
_______________________________________________________________________________________

IN THE FIELD
4. Why does Lucy Jones make the magnitude-7.8 simulated earthquake seem so real?

_______________________________________________________________________________________
_______________________________________________________________________________________
_______________________________________________________________________________________

TECHNOLOGY
5. What actions have people in California taken to help ensure safety during earthquakes?

_______________________________________________________________________________________
_______________________________________________________________________________________
_______________________________________________________________________________________
_______________________________________________________________________________________
_______________________________________________________________________________________
Invention Connection: Your Lifelines

Look around your home and neighborhood. Make a drawing of your lifelines. Where do your electricity, gas, and water come from? Where is the nearest cell phone tower? If you’re stumped, ask a parent or older sibling for help.

Brainstorm ways to prepare for an earthquake, hurricane, or tornado. Describe your disaster preparation plan.

Title: ________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________
Create a Science Poster: Natural Disaster

Research a natural disaster involving an earthquake, volcano, or tsunami. Then make a science poster presenting your research.

Research one of these disasters or choose another event:

> The Chilean earthquake on May 22, 1960
> The Alaska earthquake and tsunami on March 27, 1964
> The eruption of Mount St. Helens, Washington state, on May 18, 1980
> The eruption of Mount Pinatubo, The Philippines, on June 15, 1991
> The Indian Ocean earthquake and tsunami of Dec. 26, 2004
> The Japanese earthquake and tsunami on March 11, 2011

Your research should focus on:

> what caused the disaster.
> what effects the disaster had on the area where it occurred.
> how people in the area could have better prepared for the disaster.

Use this space to design your poster. Then create your final poster on poster board. The poster should have a title, captions or labels, and photos or diagrams.
Use this sheet to answer the *Hey, I Know That!* questions on page 30 of *Plate Tectonics*.

1. Which city would be best to live in if you really want to avoid earthquakes? Why? (pages 6 and 7)
   a. Boston, Massachusetts
   b. Athens, Greece
   c. Tokyo, Japan
   d. Seattle, Washington

2. Imagine that you are a geologist trying to measure how fast the San Andreas Fault is slipping. Where would you place two GPS receivers? How often would you measure their positions—once a week, once a month, or once a year? Why? (page 17)

3. Which of these mountain ranges is not volcanic? (page 24)
   a. Cascades, North America
   b. Himalayas, Asia
   c. Andes, South America

4. Using this map of the Hawaiian Islands, write down
   a. the direction that the Pacific Plate is moving.

   ____________________________________________
   ____________________________________________

   b. where the next Hawaiian Island will form.

   ____________________________________________
   ____________________________________________

   c. the name of the oldest Hawaiian Island still above water. (page 25)

   ____________________________________________