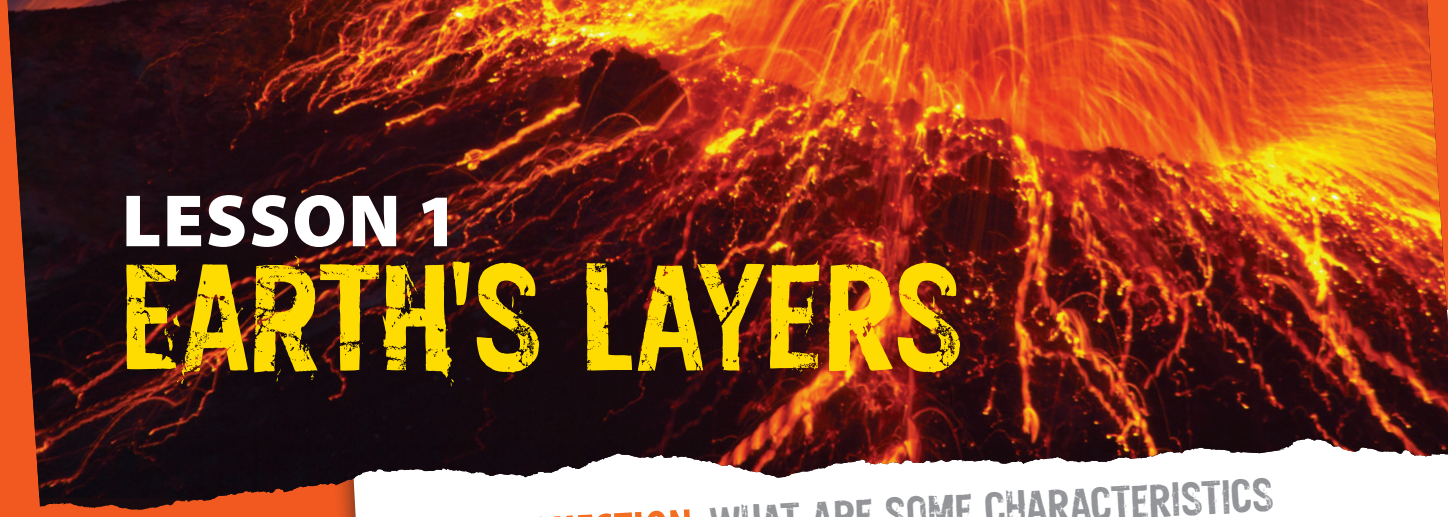


LESSON 1
EARTH'S LAYERS

FOCUS QUESTION: WHAT ARE SOME CHARACTERISTICS OF THE DIFFERENT LAYERS OF EARTH?

OVERVIEW

In this lesson, students discover that Earth has four main layers that have different thicknesses and compositions. They then combine information obtained from their activities, readings, and **LEARN™** to develop a model describing Earth's structure.

OBJECTIVES

In this lesson, students will:

- **Obtain** and combine information from **LEARN™** and the *Our Active Earth* Reader to describe and compare the characteristics of Earth's crust, mantle, inner core, and outer core.
- **Describe** how scientists use technology to investigate Earth's structure.
- **Use** observations of magnets and information from **LEARN™** to construct an explanation of how the movement of liquid iron in the outer core creates Earth's magnetic field.
- **Evaluate** models and choose the one that best describes Earth's structure.

KEY SCIENCE PRACTICES

Developing and Using Models Develop and use models to describe phenomena, including Earth's layers and Earth's magnetic field.

Obtaining, Evaluating, and Communicating Information Obtain and combine information from books and other reliable media to explain phenomena, including the characteristics of Earth's four layers.

KEY CROSSCUTTING CONCEPTS

Scale, Proportion, and Quantity Natural objects exist from the very small to the immensely large, as illustrated by the relative sizes of Earth's four layers.

BACKGROUND

Until the middle of the 20th century, geologists knew very little about the internal structure of our planet. By observing earthquakes and by using specialized tools and computer technology, scientists have been able to gather and analyze vast amounts of data about how seismic waves travel through Earth's interior. Today, scientists know that Earth is made up of several concentric layers—the crust, mantle, outer core, and inner core—each with distinctive characteristics.

→ SEE THE LESSON 1 CONTENT REFRESHER on pages XX–XX of this Teacher Guide for more information about the characteristics of the layers of Earth.

VOCABULARY

Word Wall Use the vocabulary for this lesson to begin a word wall. Have students apply the rules of syllabication to divide the words into syllables. Encourage students to use the words as they discuss and write about their observations and conclusions.

Roots and Suffixes Guide students to relate the root words *magnet* and *ocean* and the suffix -ic, which means "of or pertaining to" to better understand the words *magnetic* and *oceanic*.

SCIENCE WORDS

continent one of seven large landmasses located on Earth

continental crust the portion of Earth's crust that makes up the continents

crust the thin, rigid, outermost layer of Earth

inner core the solid, innermost layer of Earth

magma melted rock below Earth's surface; can be in the lower crust or in the mantle

magnet a material or object that produces a magnetic field

magnetic field the area of magnetic force around a magnet

mantle the thick, partly melted layer of Earth that lies beneath the crust

model a representation of an object, process, or idea

oceanic crust the portion of Earth's crust that makes up the ocean floor

outer core the liquid layer of Earth located between the mantle and the inner core

property any quality that describes; something about an object that can be observed with the senses or measured with a tool

ACADEMIC WORDS

attract to pull toward; to cause to draw near

characteristic a feature of a person, place, or thing that helps to identify it

cross section a side view of an object made by slicing through the object

repel to push away

structure the arrangement of the parts that make up a whole

three-dimensional having or appearing to have length, width, and depth

two-dimensional having or appearing to have length and width, but no depth

MATERIALS

For each student

- *Our Active Earth* Science Notebook, Lesson 1
- *Our Active Earth* Reader, "Planet Earth: Crust to Core" and "To Dig a Hole"
- sticky notes*
- index cards

For each group of students

- 1 geographic compass
- 4 bar magnets
- 1 magnetic field display tool
- 1 tablet or smartphone with Internet access*

For the teacher

- globe of Earth*
- world map*

*School supplied

PREPARATION

Elaborate Set up stations where groups of students can work together. Stations should have an area that is level. If necessary, students may work with the compasses and magnetic field tools on the floor.

ENGAGE

1. INTRODUCE PHENOMENA

Students learn about several kinds of models that can be used to represent Earth.

Activate Prior Knowledge Hold up the globe. Ask guiding questions to encourage students to share what they know about a globe of Earth.

- **What is this?** *a globe*
- **How is this globe like Earth?** *It's round and shows where land and water are.*
- **What do the blue areas represent?** *water; the oceans*
- **What are the other areas shown on this globe?** *land or continents*

Students who have studied the continents may be able to name them; you may want to let them to identify the continents on the globe.

Develop Vocabulary Write the word *model* on the board. Tell students that the globe is a model of Earth. Then refer to the world map and inform students that it is also a model of Earth. **ASK:**

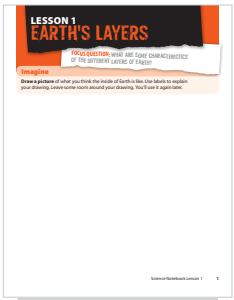
- **What is a model?** *Students may say that a model is something that looks like something else.*
- **How are the globe and the map alike?** *Both are models that represent Earth.*
- **In what way is the globe a better model of Earth? In what way is the map a better model?** *Accept logical responses from students that reflect the limitations of each kind of model.*

Build on students' operational definitions by explaining that a **model** is something that represents something else. A diagram or a drawing of an idea can be a model. Other models of Earth include computer programs and applications, such as GPS systems on smartphones. Tell the class that scientists use many kinds of models to help them understand and explore Earth. During this module, they, too, will be working with different kinds of models to learn about Earth.

Identify Misconceptions

ASK: If you could dig a deep hole into the ground, what do you think you would find? *Some students may state that they would find sand or rock. Others may think that the inside of Earth is hollow, like the globe.*

USE NOTEBOOKS **Imagine** Instruct students to draw their ideas. Point out that their sketches are models of their ideas about the inside of Earth. At this point, do not attempt to correct students' misconceptions. When students review their sketches at the end of the lesson, they should note any differences between their original ideas and those gained during the lesson.



Page 5

Extend Concepts

Ask students to name some other types of models with which they are familiar as you list them on the board. Students may name model trains, cars, and airplanes, or dolls and dollhouses. Prompt them to identify models they may have used in science or social studies classes, such as maps, models of human organs or systems, or activities that modeled how an animal might eat or move.

Stress that not all models are smaller than the actual objects. Challenge students to describe models that are larger than the objects they represent. Students may cite models of tiny insects, cells, or particles of matter.

Continue the discussion by informing the class that models can also represent processes or ideas, such as the water cycle or the revolution of Earth around the Sun. Encourage students to name additional examples of these other kinds of models.

As students discuss models, elicit from them the benefits and limitations of using a particular type of model.

EXPLORE

2. INVESTIGATE SCALE & PROPORTION

Students use **LEARN™** to explore Earth's internal structure and to identify some of the characteristics of Earth's four layers.

Build Vocabulary

Guide students to understand that a *characteristic* is a quality or trait of an object by asking them to describe the characteristics of one of the student's shoes or some other object in the classroom. Relate this academic word to the science word **property**, which refers to the color, shape, or size of the object, or what the object is made of.

Explore Earth's Layers

Divide the class into groups of four and distribute a tablet to each group. Have them open a Science Notebook to Collect Data: The Crust, page 6, and find the **LEARN™** target. Allow groups to explore the **LEARN™** model of Earth's structure, prompting them with the following questions.

- **How can you adjust the image to see inside Earth?**
- **What four layers can you see?**
- **What questions do you have about Earth's structure?**

Troubleshoot Circulate around the room to guide students in the use of **LEARN™**. Ensure that all members of the group have an opportunity to observe the model.

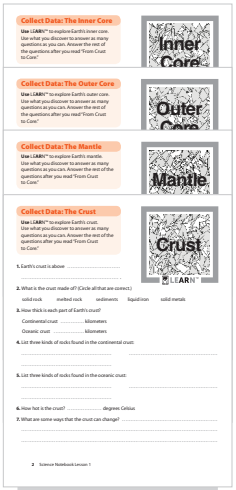
Elicit Questions

ASK: Based on your observations, what can you say about Earth's structure? *Earth has four main layers: the crust, the mantle, the outer core, and the inner core.* If students list only the core, have them observe the image again to note that Earth's core has two parts. Encourage students to share the questions they generated about Earth's structure. Record some of their questions on the board to use for discussion.

Expert Jigsaw Explain that groups will be working together to learn about the characteristics of Earth's four layers. Each member of a group will become an expert on one layer, and then share what they learn with the rest of the group. Have the members of each group count off from 1 to 4. Assign a different layer of Earth to the students with each number: 1–Crust; 2–Mantle; 3–Outer Core; 4–Inner Core. Instruct the experts for each layer to meet together as a team.

Obtain Information Ensure that each expert team has a tablet. Point out the Science Notebook page for each layer: Collect Data for The Crust, page 6; The Mantle, page 7; The Outer Core; page 8; The Inner Core, page 9. Instruct each team of experts to use the **LEARN™** target on the appropriate page to gather information about their layer.

USE NOTEBOOKS **Collect Data** Have the expert teams work together to answer the questions about their layer. Explain that the **LEARN™** model does not include the answers to all of the questions. If groups cannot find the answer to a question, they should leave that question blank.



Pages 6-9

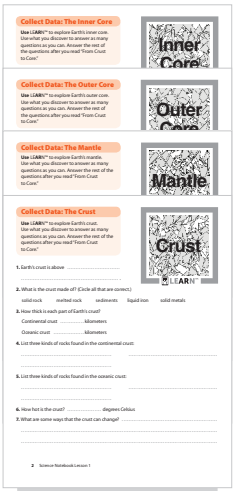
EXPLAIN

3. OBTAIN & COMBINE INFORMATION

Expert groups gather information about Earth's layers from *Our Active Earth* Reader.

Reading Jigsaw Distribute an *Our Active Earth* Reader to each student and have them open it to "From Crust to Core," pages 2–3. Instruct students to read the text about his or her assigned layer.

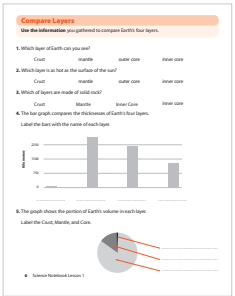
USE NOTEBOOKS **Collect Data** Have expert teams work together to answer the remaining questions about their layer. Encourage groups to double-check the accuracy of their information and correct any mistakes.



Pages 6-9

Combine Information Have the experts return to their original groups and share what they have learned about their layer with the rest of their group.

USE NOTEBOOKS **Compare Layers** Instruct students to use the information from the other experts to answer the questions about all four layers of Earth.

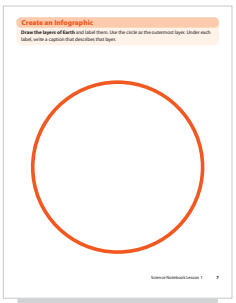


Page 10

Develop a Model Guide students to recall the **LEARN™** model of Earth's structure and the image on pages 2–3 of the *Our Active Earth* Reader. Explain that these are both cross sections, or cut-away views. A cross section is a two-dimensional model of the internal

structure of an object. A cross section of Earth is helpful in understanding the position and relative thicknesses of the layers.

USE NOTEBOOKS **Create an Infographic** Have students use their notes and what they have learned to draw a cross section of Earth's layers. Explain that infographics include labels and captions that give details about the main parts of the diagram—in this case, the four layers of Earth.


Create an Infographic

Draw the layers of Earth and label them. Use the circle as the outermost layer. Under each label, write a caption that describes that layer.

Science Notebook: Lesson 1 7

Page 11

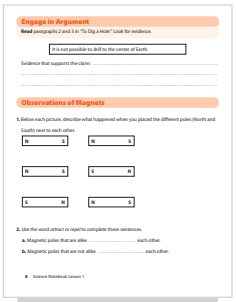
4. EXAMINE NATURE OF SCIENCE

Students learn how scientists use technology to investigate Earth's structure.

Apply Concepts Have students think about what they have learned about Earth's structure. Guide them to conclude that it's impossible to see inside our planet. Explain that because the inside of Earth is extremely hot and under deep pressure, it's impossible to dig very far into it. Then **ASK: How do you think scientists learned about Earth's structure?**

Annotate Text Features Have students read "To Dig a Hole" in the *Our Active Earth* Reader, pages 4–7. Tell them to pay particular attention to the headings and images on the pages. Distribute sticky notes and have students write a phrase that states the purpose of each image and how it relates to the headings.

USE NOTEBOOKS **Engage in Argument** When students finish the article, have students cite evidence for a claim about drilling to the center of Earth.


Engage in Argument

Read paragraphs 2 and 3 in "To Dig a Hole." Look for evidence.

It is not possible to drill to the center of Earth.

Evidence that supports the claim: .....

.....

.....

Observations of Magnets

1. Below each picture, describe what happened when you placed the different poles (North and South) next to each other.

N S | N S

N S | S N

S N | N S

2. Use the word *attract* or *repel* to complete these sentences.

a. Magnetic poles that are alike ..... each other.

b. Magnetic poles that are not alike ..... each other.

Science Notebook: Lesson 1 8

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ELABORATE

5. INVESTIGATE MAGNETS

Students investigate magnets to gain an understanding of Earth's magnetic field.

Elicit Prior Knowledge Hold up a geographic compass. Allow students to share any knowledge they have of how this instrument works. Some students may know that the needle of a geographic compass points north. Review cardinal directions. Explain that a compass is a device that allows people to find their way on land as well as to navigate on the oceans, and that the needle inside the compass is a magnet that can move freely inside the case. **ASK: What is a magnet?** *Accept any reasonable descriptions, but correct any misconceptions in student responses*. Tell students that they are now going to carry out an investigation to learn about magnets and the magnetic field, or area of magnetic force, that surrounds them.

Investigate Magnets

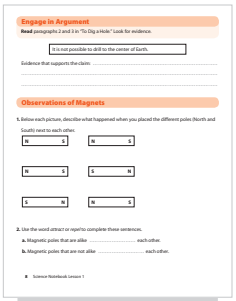
Materials for each group: 4 bar magnets, 1 geographic compass, 1 magnetic field display tool.

Divide the class into small groups and distribute the materials to each group. Point out the labels N and S on the bar magnets, and explain that these letters stand for north and south. Identify the compass and magnetic field display tool. Instruct groups to use the materials to answer the following questions.

- **How do the poles of the magnets affect each other?**
- **How does a magnet affect the needle of a compass?**
- **How does a magnet affect the iron filings in the magnetic field tool?**

Display the questions where groups can see them during their investigations. Encourage students to use the terms *attract* and *repel* in their discussions and answers.

USE NOTEBOOKS **Observations of Magnets** Have students record their observations about how magnets interact.


Engage in Argument
Read paragraphs 2 and 3 in "To Dig a Hole." Look for evidence.
It is not possible to drill to the center of Earth.
Evidence that supports the claim:
Observations of Magnets
1. Below each picture, describe what happened when you placed the different poles (North and South) next to each other.
N S
N S
N S
S N
S N
S N
2. Use the word *attract* or *repel* to complete these sentences.
a. Magnetic poles that are alike ..... each other.
b. Magnetic poles that are not alike ..... each other.
8 Science Notebook Lesson 1

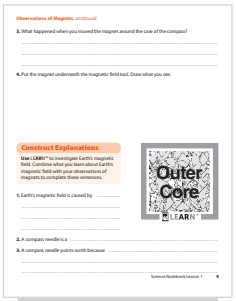
Page 12

Investigate Earth's Magnetic Field

ASK: What is Earth's outer core made of? *liquid iron*

Remind students that materials that are liquid can move from place to place, or flow. Distribute a tablet to each group. Have groups use **LEARN™** to observe how the movement of the molten iron in the outer core produces a magnetic field that extends around Earth.

USE NOTEBOOKS **Construct Explanations** First, have students complete the sentences. After class discussion about cause-and-effect, allow time for students to revisit their responses and revise them as needed to reflect accuracy.


Observations of Magnets, continued
3. What happened when you moved the magnet around the cow of the compass?
4. Put the magnet underneath the magnetic field tool. Draw what you see.
Construct Explanations
Use LEARN™ to investigate Earth's magnetic field. Combine what you learn about Earth's magnetic field with your observations of magnets to complete these sentences.
Outer Core
LEARN
1. Earth's magnetic field is caused by .....
2. A compass needle is a .....
3. A compass needle points north because .....
Science Notebook Lesson 1 9

Page 13

Identify Cause and Effect

Call the class together. Use prompts like these to help students summarize what they have learned about Earth's magnetic field.

- **A compass works because…** *Guide students to conclude that Earth is like a giant bar magnet, which causes the needle of a compass to point toward Earth's magnetic North Pole.*
- **Earth's magnetic field is caused by…** *Help students conclude that molten iron in the outer core moves slowly in circular patterns, producing an enormous magnetic field that extends outward from the center of Earth in all directions, surrounding the planet.*

EVALUATE

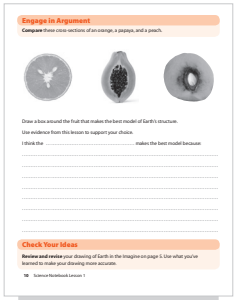
6. DEVELOP MODELS

Students apply what they have learned to compare possible models of Earth's structure.

Evaluate Models

Use the FLEX Presenter to display images of the cross sections of a peach, an orange, and a papaya, and identify each of them. Alternatively, you may display a real peach, orange, and papaya, and then cut each in half to show a cross section. Have volunteers point out the skin, flesh, and seeds in each fruit. For the peach, explain that the seed is inside the hard pit.

USE NOTEBOOKS **Engage in Argument** Ask students to make a claim about which fruit they think makes the best model of Earth's structure. Remind students to include evidence from this lesson to support their arguments.

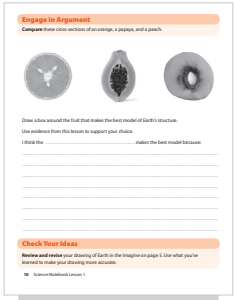

Engage in Argument
Compare these cross sections of an orange, a papaya, and a peach.
Draw a box around the fruit that makes the best model of Earth's structure.
Use evidence from this lesson to support your choice.
I think the ..... makes the best model because:
Check Your Ideas
Review and revise your drawing of Earth in the Imagine on page 5. Use what you've learned to make your drawing more accurate.
10 Science Notebook Lesson 1

Page 14

Reflect

Have pairs discuss how what they learned is different from their original models of Earth.

USE NOTEBOOKS **Check Your Ideas** Have students turn to the pictures of Earth's interior that they drew in the Imagine at the beginning of the lesson. Instruct students to use what they have learned about Earth's layers to revise their drawings so they are more accurate. If necessary, allow students to revise their drawings on a separate piece of paper and attach it to the page.


Engage in Argument
Compare these cross sections of an orange, a papaya, and a peach.
Draw a box around the fruit that makes the best model of Earth's structure.
Use evidence from this lesson to support your choice.
I think the ..... makes the best model because:
Check Your Ideas
Review and revise your drawing of Earth in the Imagine on page 5. Use what you've learned to make your drawing more accurate.
10 Science Notebook Lesson 1

Page 14

FORMATIVE ASSESSMENT

Aha! and Huh? Provide students with index cards. On one side, have them write down one or two "ahas" that reflect something they learned in this lesson. On the other side, have them write one or two "huhs" that describe what they still have questions about. Use these questions to help plan whole-class or individual remediation.

Assess Science Notebooks Use the sample answers on the reduced Science Notebook pages to assess student mastery of the concepts and practices developed in the lesson. Use your assessments to plan individual and whole-class remediation. Students' Science Notebooks should include:

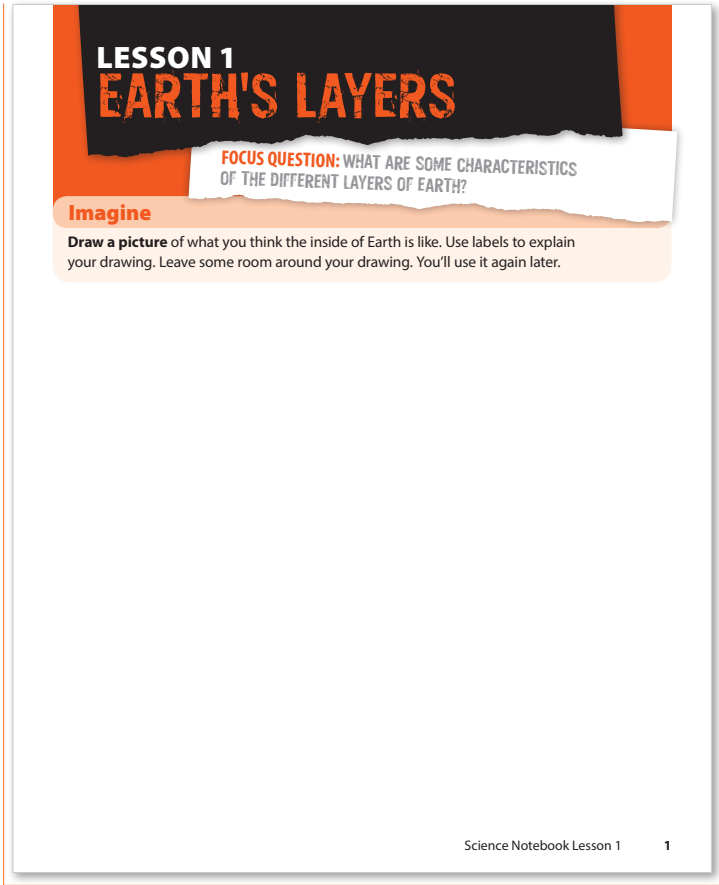
- Drawings that show the relative thicknesses and position of Earth's crust, mantle, and inner and outer cores.
- Accurate descriptions of the key characteristics of each of Earth's layers.
- Explanations of how currents in Earth's outer core produce Earth's magnetic field and how that field affects a compass.
- A claim supported by evidence as to which fruit makes the best model of Earth's structure.

REMEDIATION

To help students understand Earth's structure, have them list the names of the layers on index cards. Instruct them to write down two or three key concepts about the layer on each card; key concepts may include the materials in the layer, the depth of the layer, and whether it is solid or liquid. Then have them arrange their cards in order from Earth's inside to outside.

ENRICHMENT

Challenge students to devise other ways to make a model of Earth's structure. For example, students could cut different-sized hollow and foam balls in half and nest them, with the largest hollow ball representing the crust, the next largest foam ball representing the mantle, and two smaller balls representing the two-part core. Students could also use modeling clay to make four concentric spheres, and then cut the spheres in half to produce a cross-sectional model. Encourage ingenuity and creativity, but insist on scientific accuracy. Set up a class display where students can share their models.



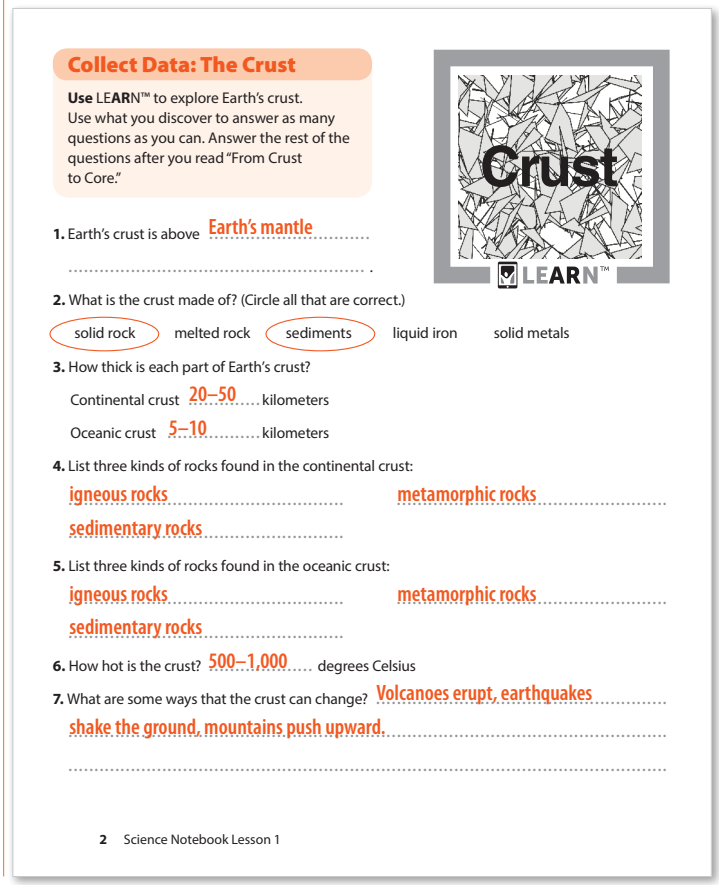
LESSON 1
EARTH'S LAYERS

FOCUS QUESTION: WHAT ARE SOME CHARACTERISTICS OF THE DIFFERENT LAYERS OF EARTH?

Imagine

Draw a picture of what you think the inside of Earth is like. Use labels to explain your drawing. Leave some room around your drawing. You'll use it again later.

Science Notebook Lesson 1 1



Collect Data: The Crust

Use LEARN™ to explore Earth's crust. Use what you discover to answer as many questions as you can. Answer the rest of the questions after you read "From Crust to Core."

Crust
LEARN™

1. Earth's crust is above Earth's mantle.

2. What is the crust made of? (Circle all that are correct.)

(solid rock) melted rock (sediments) liquid iron solid metals

3. How thick is each part of Earth's crust?

Continental crust 20–50 kilometers

Oceanic crust 5–10 kilometers

4. List three kinds of rocks found in the continental crust:

igneous rocks, metamorphic rocks, sedimentary rocks

5. List three kinds of rocks found in the oceanic crust:

igneous rocks, metamorphic rocks, sedimentary rocks

6. How hot is the crust? 500–1,000 degrees Celsius

7. What are some ways that the crust can change? Volcanoes erupt, earthquakes shake the ground, mountains push upward.

2 Science Notebook Lesson 1

Collect Data: The Mantle

Use LEARN™ to explore Earth's mantle. Use what you discover to answer as many questions as you can. Answer the rest of the questions after you read "From Crust to Core."

1. Earth's mantle is between the the crust and the outer core.

2. How thick is the mantle? 2,900 kilometers.

3. Which part of the mantle is bonded to the crust? (Circle one.)

   upper mantle middle mantle lower mantle

4. Which parts of the mantle are made of solid rock? (Circle two.)

   upper mantle middle mantle lower mantle

5. Which part of the mantle is made of partially melted rock? (Circle one.)

   upper mantle middle mantle lower mantle

6. List eight materials found in the mantle.

   olivine, garnet, magnesium oxide, iron, aluminum, calcium, sodium, potassium

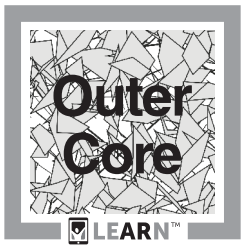
7. How hot is the mantle? ..... degrees Celsius.

8. What is the hottest part of the mantle? the lower mantle

9. How does the middle part of the mantle move? It flows very slowly, like hot tar. It moves around slowly in circles.

Collect Data: The Outer Core

Use LEARN™ to explore Earth's outer core. Use what you discover to answer as many questions as you can. Answer the rest of the questions after you read "From Crust to Core."



1. Earth's outer core is between the mantle and the inner core.

2. What is the outer core mainly made of? (Circle one.)

   solid rock melted rock sediments liquid iron solid metals

3. List four materials found in the outer core.

   iron, nickel, sulfur, oxygen

4. How thick is the outer core? 2,200 kilometers.

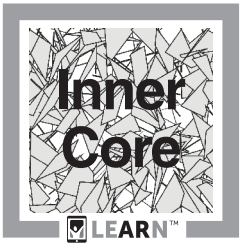
5. How thick is the outer core? 4,400–6,000 degrees Celsius.

6. How do the materials in the outer core move? They flow in huge whirlpools.

7. What does the motion in the outer core cause? Earth's magnetic field.

Collect Data: The Inner Core

Use LEARN™ to explore Earth's inner core. Use what you discover to answer as many questions as you can. Answer the rest of the questions after you read "From Crust to Core."



1. Earth's inner core is below the outer core.

2. What is the inner core mainly made of? (Circle one.)

   solid rock melted rock sediments liquid iron solid metals

3. List two materials found in the inner core.

   iron, nickel

4. How thick is the inner core? 1,200 kilometers.

5. How hot is the inner core? 5,200–6,000 degrees Celsius.

6. Why is the inner core so hot? (Circle all that are correct.)

   a. Heat is left over from when Earth formed.

   b. Materials in the inner core are burning.

   c. Radioactive materials are giving off heat.

   d. Electricity from the outer core is producing heat.

7. The materials in the inner core cannot melt because the pressure is too high for them to melt.

Compare Layers

Use the information you gathered to compare Earth's four layers.

1. Which layer of Earth can you see?

   crust mantle outer core inner core

2. Which layer is as hot as the surface of the sun?

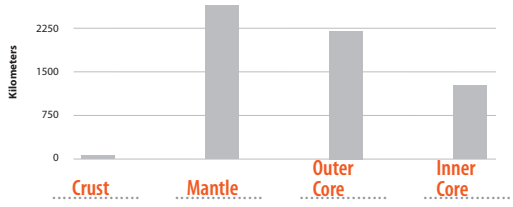
   crust mantle outer core inner core

3. Which of layers are made of solid rock?

   crust mantle outer core inner core

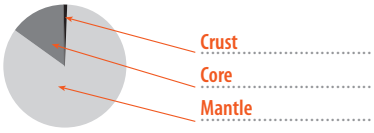
4. The bar graph compares the thicknesses of Earth's four layers.

   Label the bars with the name of each layer.



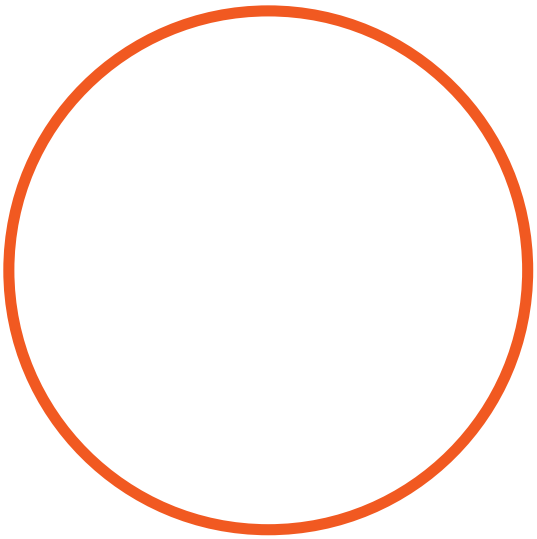
5. The graph shows the portion of Earth's volume in each layer.

   Label the Crust, Mantle, and Core.



Create an Infographic

Draw the layers of Earth and label them. Use the circle as the outermost layer. Under each label, write a caption that describes that layer.



Engage in Argument

Read paragraphs 2 and 3 in "To Dig a Hole." Look for evidence.

It is not possible to drill to the center of Earth.

Evidence that supports the claim: Evidence may include distances that drillers could dig and that they had to stop because their drill started to melt.

Observations of Magnets

1. Below each picture, describe what happened when you placed the different poles (North and South) next to each other.

a. The magnets pulled together. They attracted each other.

b. The magnets pushed apart. They repelled each other.

c. The magnets pushed apart. They repelled each other.

2. Use the word *attract* or *repel* to complete these sentences.

a. Magnetic poles that are alike attract each other.

b. Magnetic poles that are not alike repel each other.

Observations of Magnets, continued

3. What happened when you moved the magnet around the case of the compass?

The needle is attracted to the north pole of the magnet and moved as the magnet moved.

4. Put the magnet underneath the magnetic field tool. Draw what you see.

Students' drawings should show the iron filings arranged in the converging lines of a magnetic field.

Construct Explanations

Use LE**AR**N™ to investigate Earth's magnetic field. Combine what you learn about Earth's magnetic field with your observations of magnets to complete these sentences.

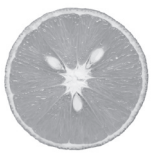
1. Earth's magnetic field is caused by the movement (or currents) of molten (or liquid) iron in Earth's outer core.

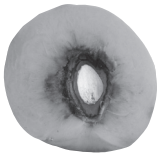
2. A compass needle is a magnet.

3. A compass needle points north because it is attracted to the North Pole of Earth's magnetic field.

Engage in Argument

Compare these cross-sections of an orange, a papaya, and a peach.





Draw a box around the fruit that makes the best model of Earth's structure.

Use evidence from this lesson to support your choice.

I think the peach makes the best model because: the peach has four main parts: skin, flesh, pit, and seed. The peach's skin is very thin, like Earth's crust. Beneath the skin is the fruit's flesh, which is much thicker than the skin. The flesh represents Earth's mantle. The peach pit is in the same relative position as Earth's outer core, but unlike the outer core, which is a moving fluid, the pit is rigid. Inside the pit is the peach seed, which is small and hard. The pit's position, size, and hardness make it a good model of Earth's inner core.

Check Your Ideas

Review and revise your drawing of Earth in the Imagine on page 5. Use what you've learned to make your drawing more accurate.