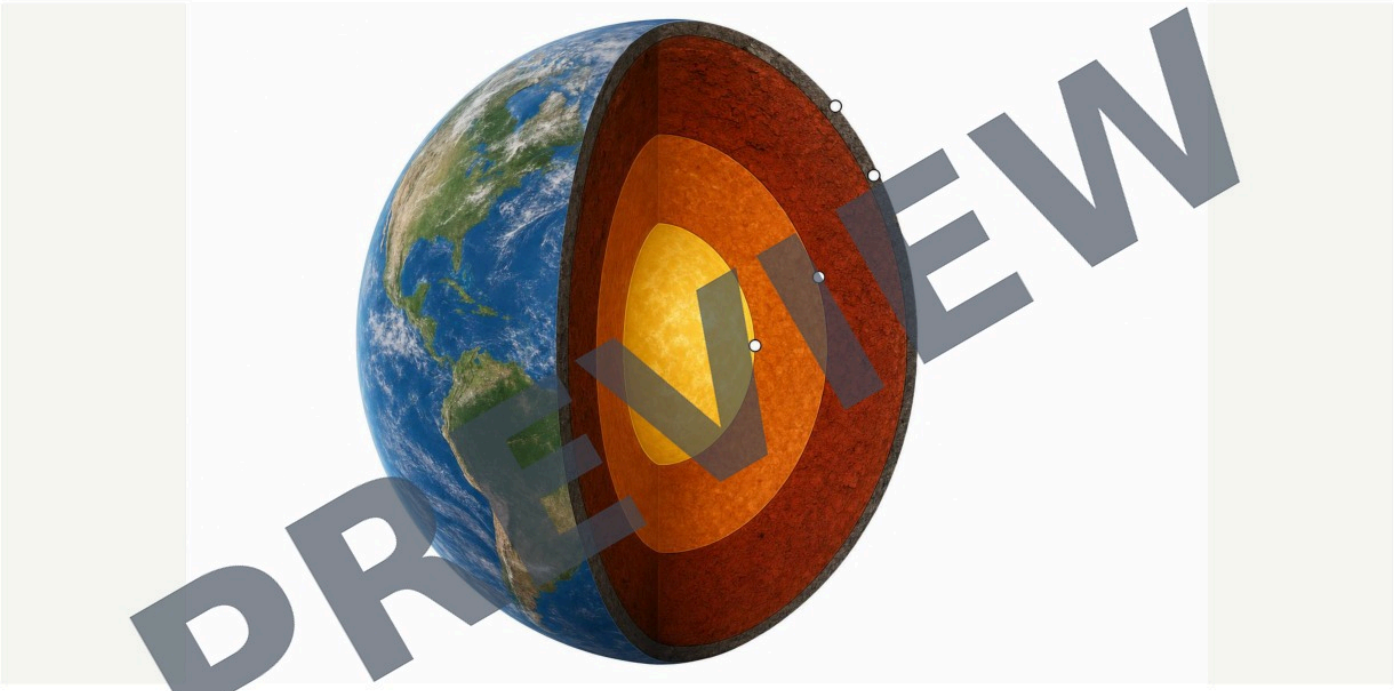
7TH GRADE · UNDERSTAND

Earth's Secret Layers: What's Really Beneath Your Feet?



01 Labels A, B, C, and D mark the crust, mantle, outer core, and inner core from outside to center.

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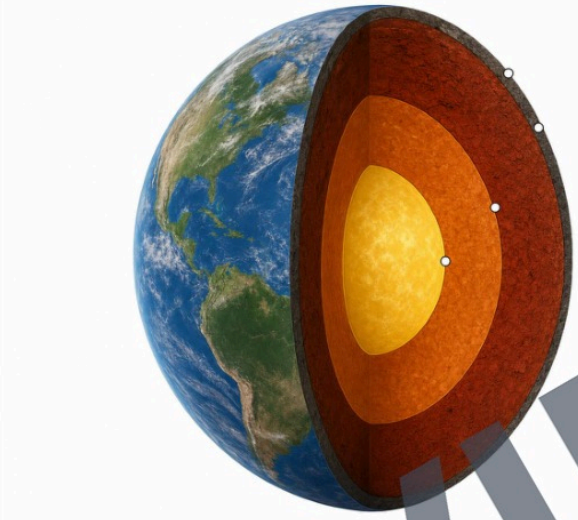

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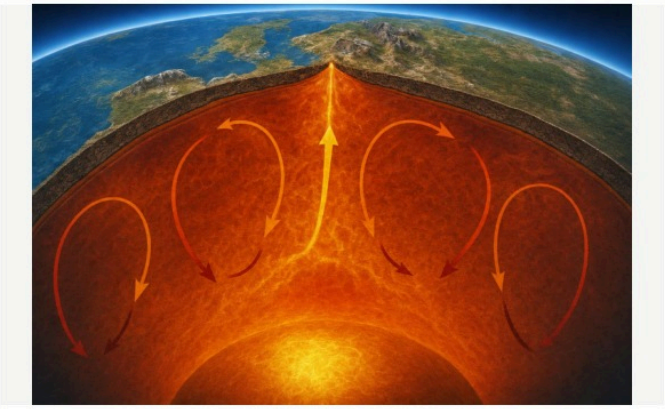
A Journey You Can't Actually Take

Right now, you're standing on top of one of the most extreme places in the solar system. Earth's interior can be as hot as, or hotter than, the Sun's glowing surface, and the pressure down there is intense enough to squeeze rock into strange new forms. No drill has ever come close to reaching it. The deepest hole humans have ever dug, the Kola Superdeep Borehole in Russia, only pierced about 12 kilometers into the crust. Earth's radius is about 6,371 kilometers, so subtract 12 from 6,371 and you get 6,359 — meaning more than 6,359 kilometers of our planet still lie completely unexplored beneath that hole. So how do scientists know what's down there? They act like detectives, using clues from seismic waves (vibrations from earthquakes) and density calculations to build a model of Earth's hidden interior.



02 Rising hot material and sinking cooler material create slow convection currents through the mantle.

Four Layers, One System

Scientists describe Earth's interior as four main layers, each with a different state of matter, composition, and density.

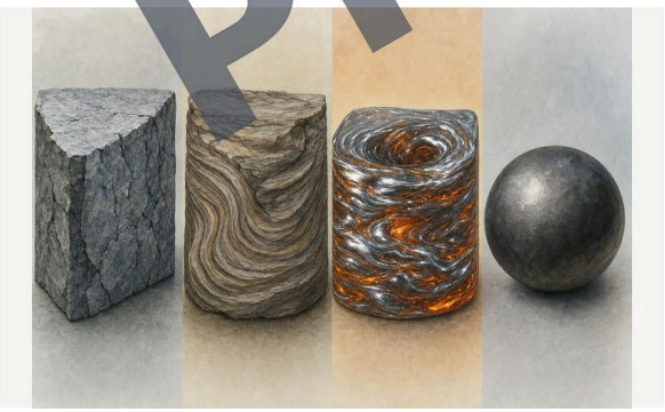
Layer	State of Matter	Composition	Approx. Density (g/cm³)
Crust	Solid	Rock	~2.7
Mantle	Mostly solid, flows slowly	Hot rock	~4.5
Outer Core	Liquid	Iron and nickel	~10.9
Inner Core	Solid	Mostly iron	~13

The **crust** is the thin, rocky shell we live on — like the skin of an apple compared to the whole fruit. Beneath it lies the **mantle**, mostly solid rock that behaves like warm caramel: it doesn't melt into liquid, but under enormous heat and pressure it can slowly deform and ooze over millions of years. Next is the **outer core**, a true liquid made of swirling iron and nickel. Finally, the **inner core** sits at Earth's center — solid metal squeezed so tightly that it can't melt, even though it's the hottest layer of all.

03 Convection in a simmering pot mirrors the slow, powerful convection happening inside Earth's mantle.

The Trend: Density Increases with Depth

Notice the pattern in the table? Density increases with depth. Billions of years ago, as Earth formed, heavier elements like iron sank toward the center while lighter materials rose toward the surface. Comparing densities helps explain *why* the layers are arranged this way, not just *what* they're called.



04 Earth's layers range from solid rock and flowing mantle to liquid outer core and solid inner core.

The Real Engine: Heat and Convection

Here's the big idea: Earth's interior isn't just sitting there — it's a system in motion, powered by energy. Heat left over from Earth's formation, heat released as the inner core slowly grows, and heat from radioactive decay inside Earth all move outward toward the surface. This flow of energy creates **convection**: warmer mantle material becomes less dense and rises, while cooler material sinks, forming slow-motion circulation patterns rather than one tidy loop. This is the same basic process as convection in a pot of simmering soup, just stretched across millions of years and thousands of kilometers. Convection is one method of thermal energy transfer, alongside conduction (heat passing directly between touching materials) and radiation (heat traveling as energy waves, like sunlight warming your face).

Why This Matters

Mantle convection is the hidden engine driving the cycling of Earth's materials. Energy constantly flows from the hot interior toward the cooler surface, and that flow drags material along with it, slowly reshaping the geosphere over deep time. Earth's interior isn't a dead, frozen ball of rock — it's a dynamic

system where density, heat, and motion work together, layer by layer, to keep our whole planet alive with change.

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01 Lesson Objective

In this lesson, you will explain how Earth's crust, mantle, outer core, and inner core differ in density and composition. You will also describe how heat flowing through the mantle causes convection, driving the slow cycling of Earth's materials.
Standard: NGSS MS-ESS2-1; TEKS 6.10B; TEKS 7.8A

Bloom's Level: Understand

Bloom's Goal: Explain how Earth's layered structure and internal heat flow work together to drive convection and the cycling of materials.

Explanation: This objective asks students to interpret and summarize relationships between density, layers, and heat transfer rather than simply recalling facts, which matches the Understand level of Bloom's Taxonomy.

Standard

NGSS MS-ESS2-1 (primary) — Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.; TEKS 6.10B (primary) — Model and describe Earth's inner core, outer core, mantle, and crust.; TEKS 7.8A (supporting) — Investigate conduction, convection, and radiation as methods of thermal energy transfer.

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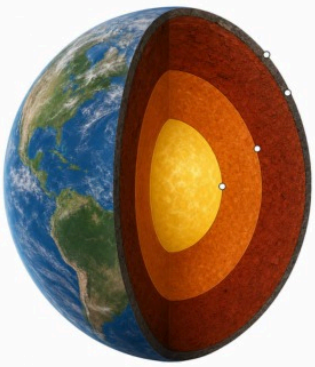
02 Vocabulary



01 Labels A, B, C, and D mark the crust, mantle, outer core, and inner core from outside to center.

> Define the terms in your own words.

Conduction *Explain in your own words:*

Convection *Explain in your own words:*

Crust *Explain in your own words:*

Density *Explain in your own words:*

Geosphere *Explain in your own words:*

Inner Core *Explain in your own words:*

Mantle *Explain in your own words:*

Outer Core *Explain in your own words:*

Radiation *Explain in your own words:*

Seismic Waves *Explain in your own words:*

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03 Multiple Choice

Read each question carefully and choose the best answer.

04 Earth's layers range from solid rock and flowing mantle to liquid outer core and solid inner core.

1. What is the correct order of Earth's layers from the surface to the center?

- **A.** Crust, mantle, outer core, inner core
- **B.** Mantle, crust, inner core, outer core
- **C.** Crust, outer core, mantle, inner core
- **D.** Inner core, outer core, mantle, crust

2. Based on the density table, what pattern is seen in Earth's layers as depth increases?

- **A.** Density decreases with depth
- **B.** Density increases with depth
- **C.** Density stays exactly the same throughout
- **D.** Density changes randomly with no pattern

3. Why did heavier elements like iron sink toward Earth's center as the planet formed?

- **A.** Iron is magnetic and was pulled to the center
- **B.** Denser materials sank while lighter materials rose
- **C.** Iron cooled faster than other elements
- **D.** The core formed first before other layers existed

4. Which state of matter best describes the outer core?

- **A.** Solid
- **B.** Liquid
- **C.** Gas
- **D.** Plasma

5. Why is the inner core solid even though it is the hottest layer of Earth?

- **A.** It is made of a different material than the outer core
- **B.** Extreme pressure keeps it from melting
- **C.** It cooled down over billions of years
- **D.** It is farther from Earth's heat source

6. What process describes warmer mantle material rising while cooler material sinks?

- **A.** Conduction
- **B.** Radiation
- **C.** Convection
- **D.** Erosion

7. Which everyday example is most similar to mantle convection?

A. A flashlight beam shining across a room

B. A metal spoon heating up in hot soup

C. Warm soup circulating as it simmers on a stove

D. Ice melting in a glass of water

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8. Which of the following is a method of thermal energy transfer where heat travels as energy waves, like sunlight warming your face?

A. Conduction

B. Convection

C. Radiation

D. Density

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9. How do scientists mainly gather evidence about Earth's deep interior, since no one can drill all the way down?

A. By sending robotic probes into the mantle

B. By studying seismic waves and density calculations

C. By melting rock samples in laboratories

D. By measuring ocean temperatures

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10. What is the main idea behind why mantle convection matters for Earth as a whole system?

A. It keeps Earth's core frozen and inactive

B. It has no real effect on Earth's surface

C. It drives the flow of energy and cycling of materials that reshape Earth over time

D. It only affects the temperature of the crust

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04 True / False

Read each statement about Earth's interior layers and thermal energy transfer. Decide whether the statement is True (T) or False (F).

02 Rising hot material and sinking cooler material create slow convection currents through the mantle.

1. The deepest hole ever drilled by humans has reached all the way to Earth's mantle.

○ True ○ False

2. Scientists learn about Earth's interior mainly by studying seismic waves and density calculations rather than by direct drilling.

○ True ○ False

3. Earth's crust is the thickest of the four main layers.

○ True ○ False

4. The mantle is mostly solid rock that can slowly flow over millions of years under heat and pressure.

○ True ○ False

5. The outer core is a liquid layer made mostly of iron and nickel.

○ True ○ False

6. The inner core is liquid because it is the hottest layer of Earth.

○ True ○ False

7. According to the density trend described in the article, density generally increases the deeper you go into Earth.

○ True ○ False

8. Convection in the mantle happens because warmer material becomes less dense and rises while cooler material sinks.

○ True ○ False

9. Conduction, convection, and radiation are all described in the article as methods of thermal energy transfer.

○ True ○ False

10. According to the article, Earth's interior is a dynamic system where heat and motion continuously drive change rather than staying frozen and unchanging.

○ True ○ False

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05 Short Answer

03 Convection in a simmering pot mirrors the slow, powerful convection happening inside Earth's mantle.

> Answer each question in 1–2 complete sentences using what you learned from the article.

1. List Earth's four main interior layers in order from the surface to the center, and describe the state of matter (solid, liquid, or mostly solid/flowing) for each.

2. Using the density data from the article, explain why the densest materials, like iron, are found at Earth's center rather than near the surface.

3. Explain what convection is and how it acts as the 'engine' that helps cycle Earth's materials over time.

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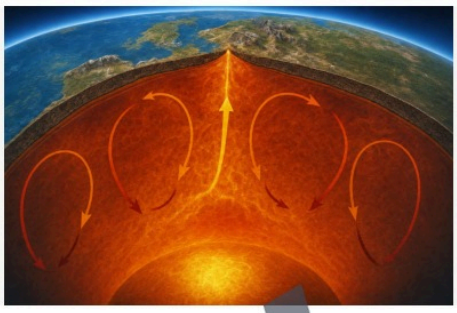
06 Case Study

Read the scenario carefully, then answer the three questions using what you learned about Earth's layers, density, and convection.



02 Rising hot material and sinking cooler material create slow convection currents through the mantle.

Scenario: Maria is building a model of Earth for her science class using clay of four different densities. She starts with a small, heavy ball of dark gray clay for the very center, then wraps a slightly less dense metallic-looking clay around it. Next, she adds a thick layer of dense, warm-colored clay that she plans to slowly squeeze and swirl to show it moving. Finally, she covers the whole model with a thin layer of light, rocky-textured clay. Maria's teacher reminds her that no one has ever drilled deep enough to actually see these layers, so scientists rely on evidence like earthquake vibrations and density calculations instead. Maria wants her model to also show energy moving, so she plans to add arrows showing warm material rising and cooler material sinking within her thick middle layer. She labels this movement 'convection' and explains that it happens because warmer material becomes less dense and rises while cooler material sinks. Maria's classmate asks why the heaviest clay is in the center instead of on the outside. Maria explains that this matches how Earth actually formed billions of years ago.

1. Using the order Maria built her clay model (center outward), identify each layer of Earth she is representing and describe one property of each layer.

2. Explain why Maria placed her heaviest, most dense clay at the center of her model instead of on the outside.

3. Describe what Maria's arrows in the thick middle layer represent, and explain how this process helps drive the cycling of Earth's materials.

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07 Discussion Questions

Discuss each question with your group and be ready to share your reasoning with the class.

04 Earth's layers range from solid rock and flowing mantle to liquid outer core and solid inner core.

1. Why do scientists describe Earth's interior using a model instead of direct observation, and what kinds of clues do they use to build that model?

2. How does the pattern of increasing density from the crust to the inner core help explain why Earth's layers are arranged in this particular order?

3. How is mantle convection similar to and different from convection you might observe in a pot of simmering soup?

4. In what ways do conduction, convection, and radiation each play a role in moving heat from Earth's interior toward its surface?

5. Why might scientists say that Earth's interior is a 'dynamic system' rather than a solid, unchanging mass of rock?

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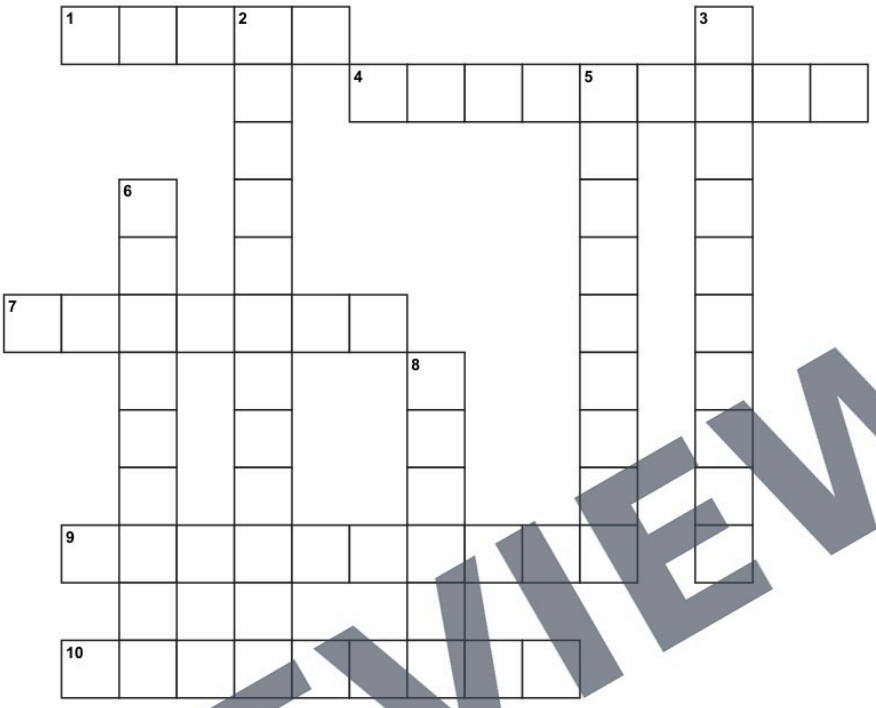
Crossword



ACROSS

1. The thin, solid, rocky outer layer of Earth that we live on.
2. The liquid layer of Earth made of swirling iron and nickel located beneath the mantle.
3. A measure of how much mass is packed into a given amount of space.
4. The circular movement of material caused by warmer, less dense matter rising and cooler, denser matter...
5. The solid, rocky part of Earth, including its interior layers and surface materials.

DOWN

1. Vibrations caused by earthquakes that scientists study to learn about Earth's interior.
2. A method of heat transfer where thermal energy passes directly between touching materials.
3. A method of heat transfer where energy travels as waves, like sunlight warming your face.
4. The solid, extremely hot metal layer at the very center of Earth made mostly of iron.
5. The thick layer beneath the crust made of mostly solid hot rock that can slowly flow over millions of years.

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Word Search

T E C S S C R N S E Y U O T S I
A I M M D I C U E T S I C E U I
C W G A E V O O I E N S C T T E
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FIND THESE WORDS

Seismic Waves
Conduction
Convection
Geosphere
Inner Core
Outer Core
Radiation
Density
Mantle
Crust