Puzzling Evidence

What evidence suggests that continents move?

• In the late 1800s, Alfred Wegener proposed his hypothesis of continental drift.

• According to this hypothesis, the continents once formed a single landmass, broke up, and drifted.
What evidence suggests that continents move?

• Several lines of evidence support Wegener’s hypothesis.

• Fossils of the same species are found on continents on separate sides of the Atlantic Ocean.

• The locations of mountain ranges and rock formations and evidence of ancient climatic conditions also support Wegener’s hypothesis.
What is Pangaea?

• About 245 million years ago, the continents were joined in a single large landmass called **Pangaea**.

• About 200 million years ago, a large rift formed and Pangaea began to break into two continents, *Laurasia* and *Gondwana*.

• Then, Laurasia began to drift northward, and a new rift separated Laurasia into the continents of North America and Eurasia.
What is Pangaea?

• At the same time, Gondwana also broke into two continents.

• One continent contained land that is now the continents of South America and Africa.

• The other continent contained land that is now Antarctica, Australia, and India.
What is Pangaea?
What discoveries support the idea of continental drift?

• For many years, scientists did not accept Wegener’s ideas because they could not determine how continents moved.

• In the mid-1900s, scientists began mapping the sea floor and discovered huge, underwater mountain ranges called **mid-ocean ridges**.

• The discovery of mid-ocean ridges eventually led to the theory of plate tectonics, which built on some of Wegener’s ideas.
What discoveries support the idea of continental drift?

• Rock samples from the sea floor revealed that the youngest rock is closest to the ridge, while the oldest rock is farthest away.

• Even the oldest oceanic crust is young compared to continental crust.

• Also, sea-floor rock contains magnetic patterns.
What discoveries support the idea of continental drift?

• To explain the age and magnetic patterns of sea-floor rocks, scientists proposed a process called **sea-floor spreading**.

• In this process, molten rock from inside Earth rises at the ridges and forms new oceanic crust.

• Older crust is pushed away from the ridge, and the sea floor slowly spreads apart.
What discoveries support the idea of continental drift?

- Scientists also discovered huge trenches in the sea floor where oceanic crust sinks into the asthenosphere.

- Older crust is thus being destroyed at the ocean trenches at the same rate as new crust is forming at the ridges.

- In this manner, Earth remains the same size.
A Giant Jigsaw

What is the theory of plate tectonics?

• Scientists began to form a new theory to explain continental drift, mid-ocean ridges, and sea-floor spreading.

• **Plate tectonics** is a theory that describes large-scale movements of Earth’s lithosphere.

• It explains how and why features in Earth’s crust form and continents move.
What is a tectonic plate?

• The lithosphere is divided into pieces called **tectonic plates**, which move around on top of the asthenosphere.
Boundaries

What are the three types of plate boundaries?

- Plate boundaries may be on the ocean floor, around the edges of continents, or even within continents.

- The three types of plate boundaries are convergent boundaries, divergent boundaries, and transform boundaries.

- Each type is associated with characteristic landforms.
What are the three types of plate boundaries?

- **Convergent boundaries** form where two plates collide. This can happen in three ways, depending on the types of crust involved.
What are the three types of plate boundaries?

- At a **divergent boundary**, two plates move away from each other, and magma rises to form new lithosphere at mid-ocean ridges.
What are the three types of plate boundaries?

- A boundary at which two plates move past each other horizontally is called a **transform boundary**. At transform boundaries, the motion of the two plates often produces earthquakes.
What causes tectonic plates to move?

- Scientists have proposed three mechanisms to explain how tectonic plates move: mantle convection, ridge push, and slab pull.

- Hotter parts of the mantle rise as cooler, denser parts sink. This kind of movement of material due to differences in density is called convection.

- Mantle convection drags the overlying tectonic plates.
What causes tectonic plates to move?

• The mechanism called ridge push moves plates away from mid-ocean ridges as rock cools and becomes more dense.

• Newly formed rock at a mid-ocean ridge is warm and less dense than older, adjacent rock, which slopes downward away from the ridge.

• As the newer rock cools and becomes denser, it moves down the slope, pushing the rest of the plate away from the mid-ocean ridge.
What causes tectonic plates to move?

• In the mechanism called slab pull, a plate moves because it is pulled along when its denser edge sinks beneath Earth’s surface.

• The leading edge of a sinking plate is colder and denser than the mantle, so it sinks. The rest of the plate follows.

• Many scientists think slab pull is the most important mechanism driving plate motion.
Answers for 1–3 should represent students’ current thoughts, even if incorrect.

1. F; T; F; F

2. Sample answer: Larger cubes will displace more punch than smaller cubes. Cubes that are more submerged will displace more punch than others that are floating on top.

3. Sample answer: Divergent means differing. It also means moving away from a common point. Convergent means meeting or coming together.

4. Students’ annotations will vary.
5. South America and Africa
   Fossil evidence: have corresponding distribution of both types of fossils
   Mountain evidence: no evidence shown on map

North America and Europe
   Fossil evidence: no evidence shown on map
   Mountain evidence: have corresponding distribution of mountains

6. See students’ pages for annotations.
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7. They did not have evidence of how continents could move.
8. Old crust is destroyed at the same rate as new crust forms.
9. youngest rock: closest to mid-ocean ridge; oldest rock: furthest from ridge
10. Students should include information on what the theory is and the evidence scientists have found to support the theory.

11. See students’ pages for annotations.

12. B
ANSWERS 208-209

13. *See students’ pages for annotations.*
14. The denser plate subducts because it is heavier. It sinks below the less dense plate.
15. Transform boundaries are different because the plates slide past each other parallel to Earth’s surface, they do not move closer or farther apart from each other.
16. See students’ pages for annotations.

17. Mantle convection: Convection currents drag the overlying tectonic plates with them. However, many scientists don’t think that this force is large enough to explain plate motion.

Ridge push: New rock is elevated at the mid-ocean ridge because it warmer and less dense than older rock. As the newer rock cools, it becomes denser and flows down the slope of the asthenosphere, pushing the rest of the plate away from the mid-ocean ridge.

Slab pull: As part of a plate sinks into the asthenosphere, it’s weight pulls the rest of the plate along with it. This force is thought to be the most important force behind tectonic plate motion.
18. Pangaea
19. North American
20. transform
21. slab pull
22. Tectonic plates move mainly because of slab pull, then ridge push, and least of all, due to convection currents. In the mantle, cooler materials sink, displacing warmer materials. This motion sets up convection currents. Some of the tectonic plate motion we observe today is due to these currents. Without these currents, the rate of motion would likely be slower.
Lesson Review Answers

1. tectonic plates
2. plate tectonics
3. convection
4. convergent
5. continental
6. mountains
7. Continental lithosphere is thicker and less dense than oceanic lithosphere.
8. Convergent: two plates collide, three types of collisions can occur
   Divergent: two plates move away from each other, most on ocean floor
9. Cool rock material sinks because it is denser and heavier than warm rock is.
10. Mantle convection: As mantle convects, it drags tectonic plates with it; not likely to create the amount of force needed to explain plate motion.

Ridge push: New warm, light rock at mid-ocean ridges is elevated relative to the older, adjacent rock, which is denser and colder. As the new rock cools, it becomes denser and flows down the slope of the asthenosphere, away from the mid-ocean ridge. At the same time, it also pushes the rest of the plate away from the mid-ocean ridge.

Slab pull: At subduction zones, denser plates subduct beneath less dense plates. The leading edge of a subducting plate is colder than the mantle and sinks, pulling the rest of the plate with it.

Scientists think slab pull explains the force needed to explain plate motion.