

## Plate Tectonics • Section Summary

## Convection and the Mantle

### Key Concepts

- How is heat transferred?
- What causes convection currents?
- What causes convection currents in Earth's mantle?

The movement of energy from a warmer object to a cooler object is called heat transfer. Heat is always transferred from a warmer substance to a cooler substance. There are three types of heat transfer: radiation, conduction, and convection.

The transfer of energy through empty space is called radiation. Heat transfer by radiation takes place with no direct contact between a heat source and an object. For example, radiation enables sunlight to warm Earth's surface.

Heat transfer by direct contact of particles of matter is called conduction. In conduction, the heated particles of a substance transfer heat to other particles through direct contact. An example is when a spoon heats up in a hot pot of soup.

The transfer of heat by the movement of a heated fluid is called convection. Fluids include liquids and gases. During convection, heated particles of a fluid begin to flow, transferring heat energy from one part of the fluid to another.

Heat transfer by convection is caused by differences in temperature and density within a fluid. Density is a measure of how much mass there is in a volume of a substance. When a liquid or gas is heated, the particles move faster. As they move faster, they spread apart. Because the particles of the heated fluid are farther apart, they occupy more space. The fluid's density decreases. But when a fluid cools, the particles move closer together and density increases.

An example of convection occurs in heating a pot of soup on a stove. As soup at the bottom of the pot gets hot, it expands and becomes less dense. The warm, less dense soup moves upward, floating over cooler, denser soup. At the surface, the warm soup spreads out and cools, becoming denser. Then gravity pulls this cooler, denser soup down to the bottom, where it is heated again and begins to rise. This flow that transfers heat within a fluid is called a convection current. The heating and cooling of the fluid, changes in the fluid's density, and the force of gravity combine to set convection currents in motion. Convection currents continue as long as heat is added to the fluid.

Convection currents flow in the mantle. The heat source for these currents is heat from Earth's core and from the mantle itself. Hot columns of mantle material rise slowly. At the top of the asthenosphere, the hot material spreads out and pushes the cooler material out of the way. This cooler material sinks back into the mantle. Convection currents like these have been moving inside Earth for more than four billion years!

**Plate Tectonics • Guided Reading and Study****t Convection and the Mantle**

*This section describes how heat is transferred from Earth's hot core through the mantle.*

**Use Target Reading Skills**

*As you read about heat transfer, complete the outline to show the relationships among the headings.*

Convection and the Mantle
I. _____
A. _____
B. Conduction
C. _____
II. Convection Currents
III. _____
_____
_____

**Types of Heat Transfer**

1. The movement of energy from a warmer object to a cooler object is called \_\_\_\_\_

2. List the three types of heat transfer.

a. \_\_\_\_\_ b. \_\_\_\_\_ c. \_\_\_\_\_

3. What is radiation? \_\_\_\_\_

4. What are two forms of radiation? \_\_\_\_\_

5. What is conduction? \_\_\_\_\_

6. What is an example of conduction? \_\_\_\_\_

Name \_\_\_\_\_ **Date**----- Class\_\_\_\_\_

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## **Convection and the Mantle** *(continued)*

7. What is convection? -----  
\_\_\_\_\_
8. Heat transfer by convection is caused by differences **of**-----  
and density within a fluid.
9. A measure of how much mass there is in a volume of a substance is  
\_\_\_\_\_
10. Circle the letter of the sentence that describes what happens to a fluid  
when its temperature increases.
- a. Its particles occupy less space.
  - b. Its density decreases.
  - c. Its particles move more slowly.
  - d. Its particles settle together more closely.

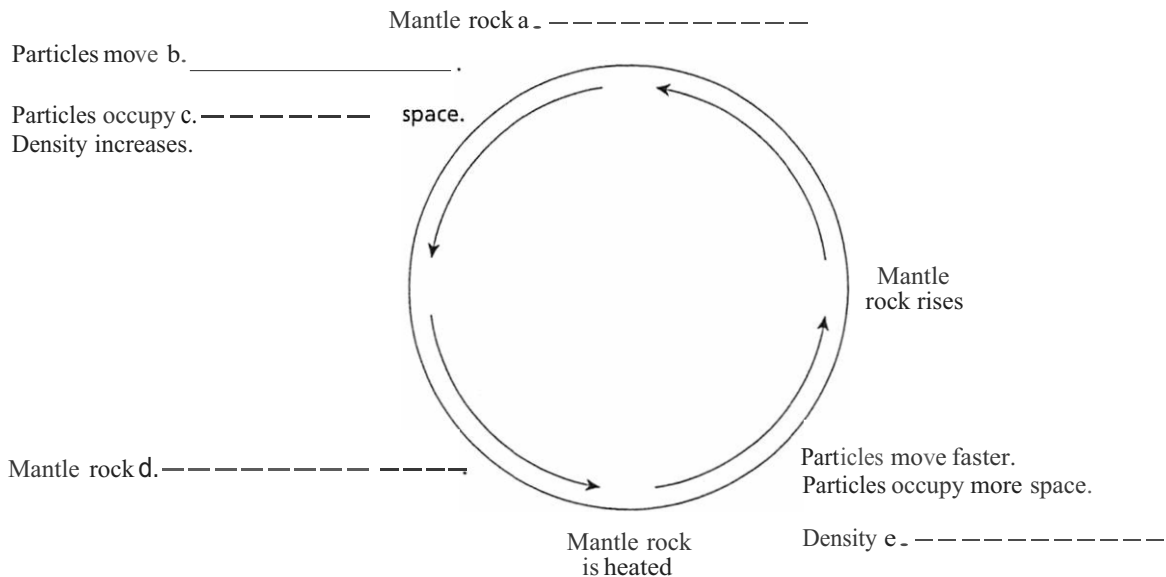
## **Convection Currents**

11. What three factors set convection currents in motion? -----  
\_\_\_\_\_
12. What happens to convection currents when the liquid or gas is no longer  
heated?  
\_\_\_\_\_

**Plate Tectonics • Guided Reading and Study**

**Convection Currents in Earth**

13. Complete the graphic organizer to show the relationships among heat, movement, and density in mantle rock.



f. Why is this relationship shown as a cycle? \_\_\_\_\_

g. In the cycle shown, where would mantle rock be the densest? \_\_\_\_\_

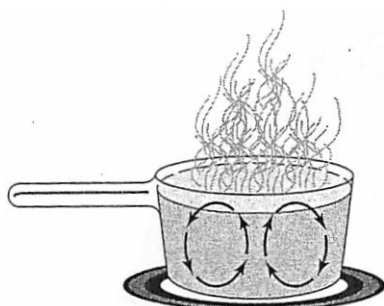
14. Is the following sentence true or false? The heat source for the convection currents in the mantle is the sun. \_\_\_\_\_

**Plate Tectonics • Review and Reinforce**

## Convection and the Mantle

### Understanding Main Ideas

*Label each figure by writing the type of heat transfer it shows.*



1. \_\_\_\_\_



2. \_\_\_\_\_



3. \_\_\_\_\_

*Answer the following questions in the spaces provided.*

4. What are convection currents and what causes them?

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5. What causes convection currents in Earth's mantle?

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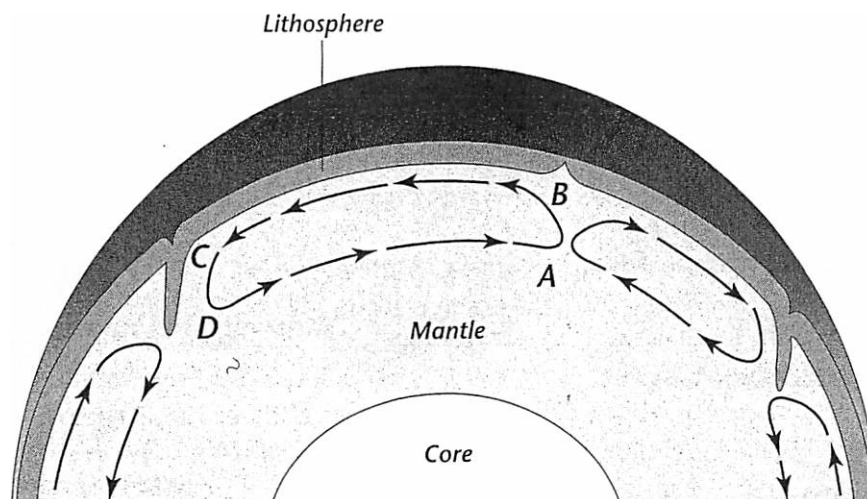
### Building Vocabulary

*If the statement is true, write true. If it is false, change the underlined word or words to make the statement true.*

6. The transfer of energy through empty space is called convection.
7. The movement of energy from a warmer object to a cooler object is called heat transfer.
8. Conduction is heat transfer by direct contact of particles of matter.
9. Radiation is the transfer of heat by the movement of a heated fluid.
10. Density is a measure of how much heat there is in a volume of a substance.

**Plate Tectonics • Enrich****What's Happening During Convection?**

The figure below shows a convection cell in Earth's mantle. A convection cell is one complete loop of a convection current. Use the figure to answer the questions that follow.



Answer the following questions on a separate sheet of paper.

1. Where does the heat come from that drives this convection current in the mantle?
2. Where is the temperature of the mantle material greater at point A or point B? Explain why.
3. Where is the density of the material greater, at point B or point C? Explain why.
4. What causes the convection cell to turn to the left at point B?
5. What happens to the temperature and density of the material between points B and C?
6. What force causes the convection cell to turn down at point C?
7. What happens to the temperature and density of the material between points D and A?
8. What causes the convection cell to turn up at point A?
9. How do you think this convection cell might affect the crust material above it?