Convection

Lesson Overview

In this lesson, students will learn what causes convection inside the Earth (and in everyday instances such as boiling a pot of water or in the air). They will connect their learning about convection to develop explanations about the motion of the lithospheric plates.

Standards Addressed

SC 2005 8-3.6 Explain how the theory of plate tectonics accounts for the motion of the lithospheric plates, the geologic activities at the plate boundaries, and the changes in landform areas over time.

SC 2014 8.E.5A.4 Construct explanations for how the theory of plate tectonics accounts for (1) the motion of lithospheric plates, (2) the geologic activities at plate boundaries, and (3) the changes in landform areas over geologic time.

NGSS MS-ESS 2-1 Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.

MS-ESS 2-3 Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.

Disciplinary Literacy Best Practices

GIST Summary

Lesson Plan

Time Required: One-Two 60-minute Class Periods

Disciplinary Vocabulary: convection, density

Materials Needed:

- Article: "Convection" (from Britannica School Middle)
- Concept Web
- Bottles of Hot and Cold Water, Food Coloring
- Worksheet: Applications of Convection

Assessment: Worksheet: Applications of Convection, GIST Summary, Exit Ticket

Engage

- Teacher will demonstrate convection using two bottles of blue colored cold water and two bottles of yellow colored hot water.
- See http://www.youtube.com/watch?v=RCO90hvEL1I for a model of this demonstration.
- Key Questions: "What do you think caused one bottle to mix and the other bottle to not mix? How is this similar to what happens inside the Earth?"

Explore

- Students will read the article titled "Convection". As students read, they should highlight key words or phrases in the text that help them answer the question "What is convection?"
- After reading, students will use their highlighted words and phrases to create a GIST statement to summarize the main idea of the article. GIST statements are short summaries (20 words or less) for a selection of text.
- They will share their GIST summaries with their group.

Explain

- Students will use their GIST summaries and information from the reading to complete a concept web of the information learned about convection.

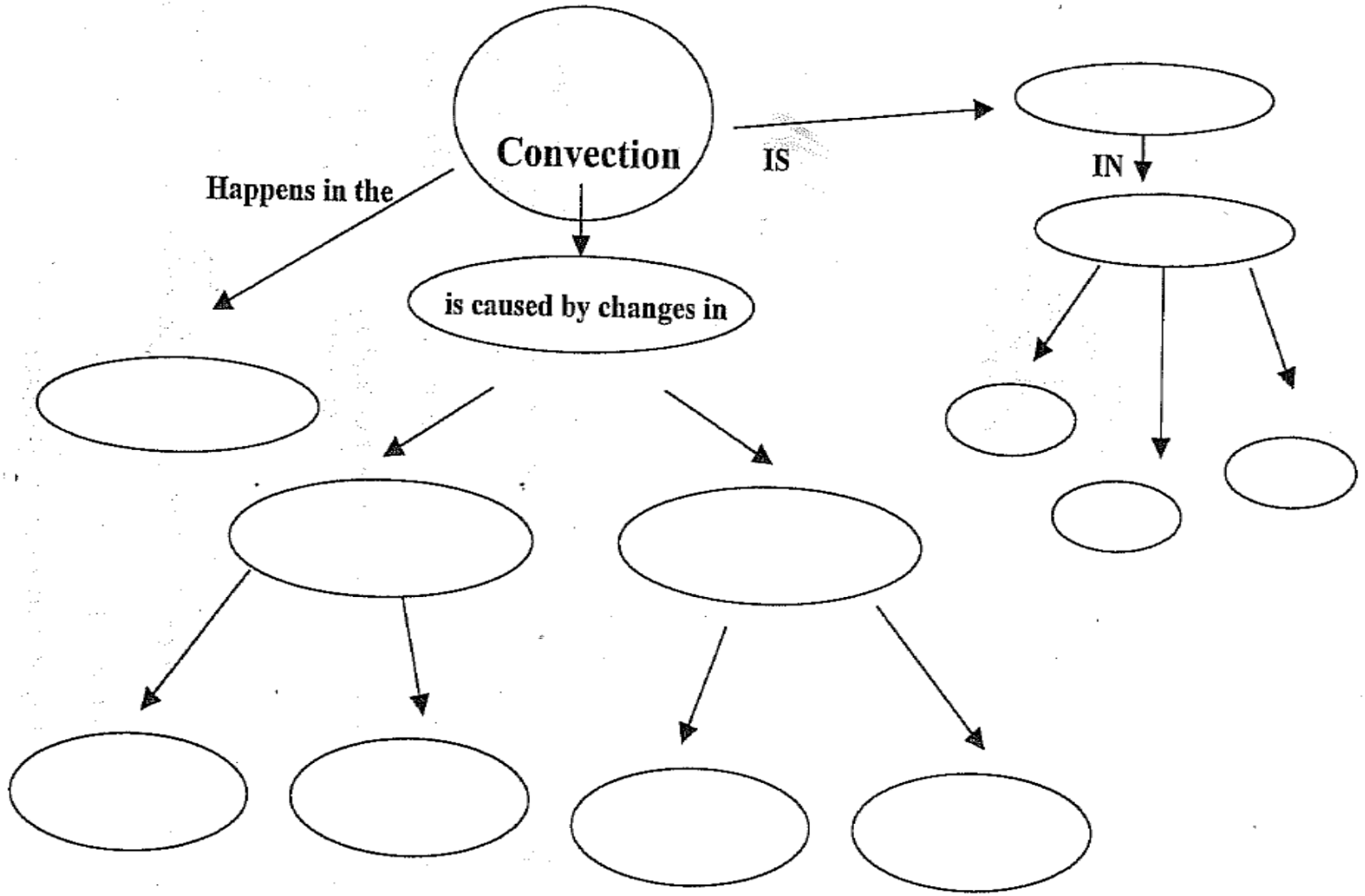
Extend

- Students will complete a lab to explore convection, such as the one in the STC Catastrophic Events kit.
- Students will complete a worksheet of applications of convection to daily life.

Teacher Biographical Information

Lesson Author:

Pam Warren is a teacher in Laurens County district 56 at the ISA, Institute for Student Advancement at Clinton High School. This is currently her 15-year teaching middle school.



Convection

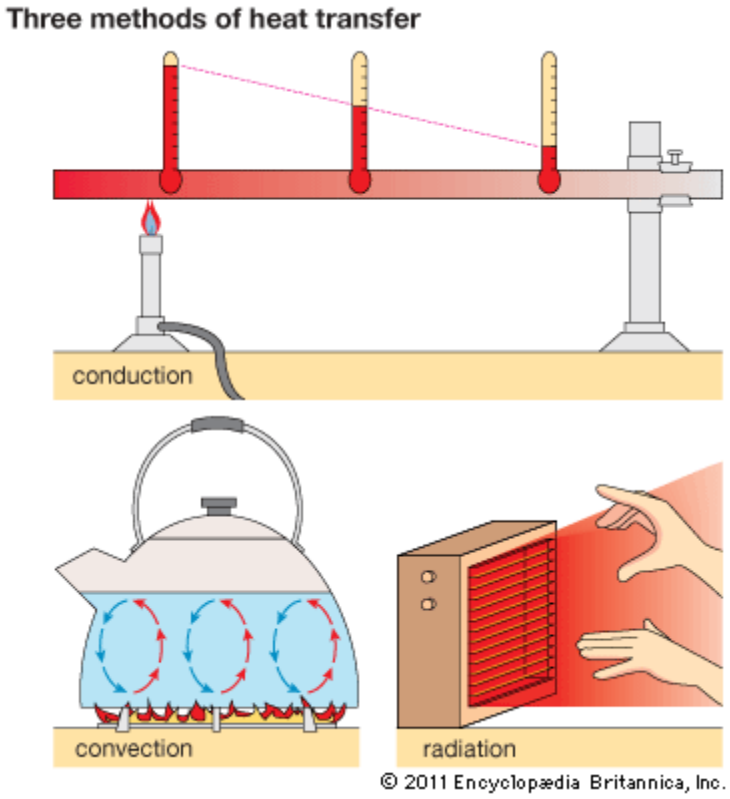
The method of heat transfer called convection occurs in fluids—that is, liquids and gases. It is usually a fairly rapid process. It depends upon the movement of the material that is heated. The motion is a result of changes in density (mass per unit volume) that accompany the heating process. Water in a teakettle is heated by convection. A hot stove also heats the air in a room by convection.

When a fluid is heated, its density decreases. The particles of the fluid speed up and spread out. The fluid expands, becoming more buoyant. A warmer volume of fluid will rise, while a colder and thus more compacted volume of fluid will descend.

In a teakettle being heated over a burner, the water in contact with the hot bottom of the kettle is heated by conduction. However, the heat spreads through the water by convection. The water at the bottom of the kettle becomes hotter, more energetic, and less dense than the rest of the water. Currents of the hot water rise up, pushing aside the colder water at the top of the kettle. This colder water sinks to the bottom, where it is then heated. This water then rises up, and the process is repeated. Convection transmits heat via such circulation currents of rising and descending fluid.

This process is called natural convection. Another familiar example of natural convection is the circulation of air from a hot-air furnace. When a liquid or gas is moved from one place to another by some mechanical force (rather than by differences in density), the process is known as forced convection. The circulation of air by an electric fan is an example of forced convection.

Taken from *Heat* - Britannica School Middle (DISCUS)



WHAT CAUSES THE PLATES TO MOVE?

The causes of plate motions are not completely understood, but a major factor appears to be giant convection cells (churning motions) in the mantle. Currents of hot material rise while currents of colder material sink, forming roughly circular cells—a common pattern of heat circulation that can also be seen in a pot of boiling water. In this way, the planet's interior redistributes heat resulting from the decay of long-lived radioactive elements such as uranium. Plates may also be pulled along by a subducting margin as the dense crust sinks into the mantle. There is evidence that some old plate fragments may have sunk almost to the core.

Scientists are now almost certain that Wegener's Pangea existed. It probably started to break apart from about 240 million to 200 million years ago after having been assembled from earlier continents only a few tens of millions of years earlier. It now seems that earlier incarnations of Pangea may have occurred, as part of a roughly 400-million-year-cycle of the breakup and reassembly of supercontinents.

Taken from *Plate Tectonics* –Britannica school middle (on DISCUS)

Worksheet: Applications of Convection

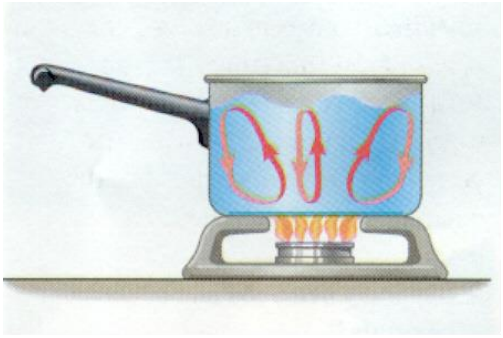
Use your notes and concept web to answer the following questions.

1. In what layer of the Earth does convection happen?

2. Convection is caused by changes in what two things?

3. How does convection affect the crust above it?

4. What layer of the earth provides the heat that causes convection to happen?



5. What is providing the heat in the above picture to start convection?

6. What happens to make the water (in the picture) move down?

7. On the picture label where there is high density.

8. On the picture label where there is low density.

9. How is this picture similar to convection in the Earth?

10. What would happen to the convection current if the pot is taken off the stove?