Convection Model Procedures

Note: This activity is adapted from the GEMS curriculum guide, Convection: A Current Event. This guide and others are available from the Lawrence Hall of Science; www. lhs.berkeley.edu.

Focus Question: How do differential heating and density affect earth processes?

Phenomenon: Many processes on earth are driven by convection currents

Summary: Students observe convection in water due to temperature differences and describe the pattern of water movement. During a class discussion students learn that the same process happens in the oceans, atmosphere and earth's mantle.

Lesson goals:

- observe how temperature changes can cause density changes in water.
- use those observations to predict how air moves in different environments.
- understand that temperature-driven density changes will produce currents in a fluid medium
- learn that convection happens in the Earth's atmosphere, oceans and the mantle

Prior knowledge: Students should have a basic understanding of density

Materials: This is for the model set-up for each student group (multiply by number of student groups to get amounts needed for whole class)

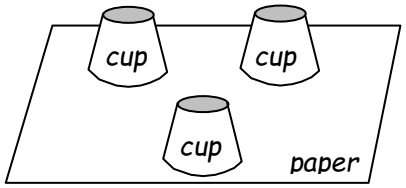
1 plastic tub	3 plastic cups	1 baggie with a rock in it
pitcher of water	1 Styrofoam cup	2 pieces white paper
ice	2 small paper cups	
boiling water	2 droppers	

2 bottles different color food coloring Optional: colored ice cubes, salt water

Introduction:
What is a current? Where have you seen them? What do you think causes them?

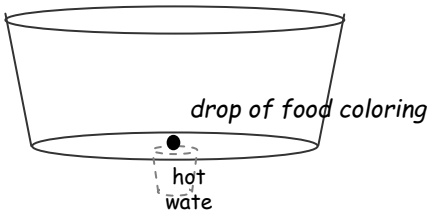
Procedure:

PART (1)



1. Place a piece of white paper on the tabletop.
2. Arrange 3 upside down plastic cups as if they were at the corners of a triangle as shown to the right; be sure to leave room between the cups. These cups will support your plastic pan.
3. Fill your plastic pan 2/3 full of *room temperature* (not hot not cold) tap water and place it on top of your upside down plastic cup tripod.
4. Put a small amount of food coloring into each of the small paper cups, a different color in each (DO NOT dilute with water).
5. Fill a styrofoam cup with steaming hot water as full as you can without spilling it and slide it under the center of your pan. (be careful with the hot water!)
6. <u>Predict what will happen</u> if you put a drop of food coloring in the middle of the bottom of your pan above your heat source (DO NOT put the drop in yet!)

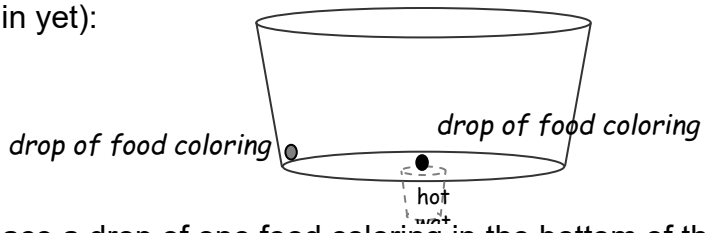
7. Place a piece of white paper behind your pan so that you can see the movement of the food coloring better. Use your eyedropper to get a drop of food coloring. CAREFULLY place the tip of the eyedropper at the bottom of the middle of the pan. Once the eyedropper tip is at the bottom, GENTLY squeeze out a bit of the food coloring to create a spot about the size of a nickel or dime; slowly and very carefully remove the eyedropper.



8. *Observe and record what happens to the drop of food coloring, use* arrows to show the general path taken by the drop of food coloring in a sketch. Use handout below if you like, or blank paper or notebook pages.
9. Dump out your water and get a pan of clean tap water.

PART (2)

10. Set your pan up with fresh steaming hot water under the center of the pan. Predict what will happen if you place a drop of food coloring in the bottom center *and* place another drop of a different color at the bottom near to the edge of the pan as shown below (DO NOT put the drops in yet):



11. Ever so gently and carefully place a drop of one food coloring in the bottom of the center of your pan and a drop of the other food coloring at the bottom near to the edge of the pan. *Observe and record what happens to the drops of food coloring.* Use arrows to show the general path taken by the drops of food coloring in a sketch

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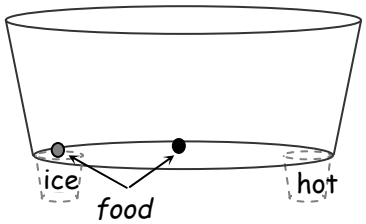
PART (3)

13. Set your pan up with fresh steaming hot water at one end of the pan and a styrofoam cup completely filled with ice under the opposite end of the pan. [Alternatively, you can fill a cloth tea bag with ice and place it in the water on one side – you can weigh the baggie with a few rocks to keep it from floating.] Predict what will happen if you place a drop of food coloring in the center of the pan *and* another drop of a different color just above the ice as shown below (DON'T put the drops in yet):



14. Ever so gently and carefully place a drop of one food coloring in the bottom of the center of your pan and a drop of the other food coloring just above the ice.
15. *Observe and record what happens to the drops of food coloring.* Use arrows to show the general path taken by the drops of food coloring.

Summary of Key Concepts

Density is affected by transfer of heat
→water and air at higher temperatures are less dense than water and air at low temperatures

Density differences create convection currents
→warm fluids are less dense and will rise,
→cold fluids are more dense and will sink
→water from the sides flows in to fill the space vacated by the warming water
This results in a convection current.

Deeper ocean currents are caused by convection (due to temperature, and salinity gradients)

Convection currents also influence atmospheric circulation, including wind, weather and ocean surface currents – based on the same principles you observed in the water

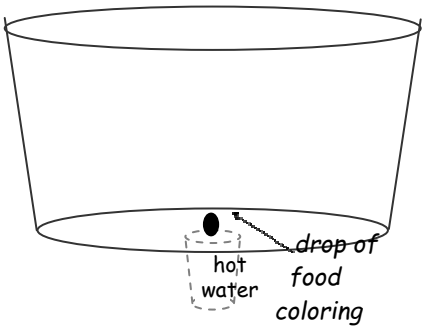
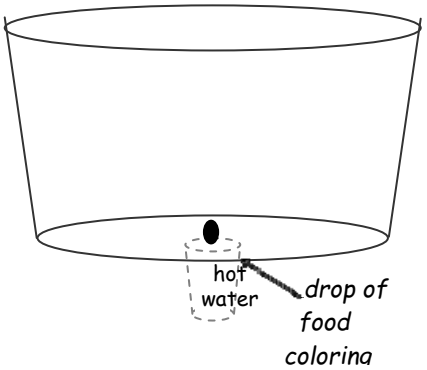
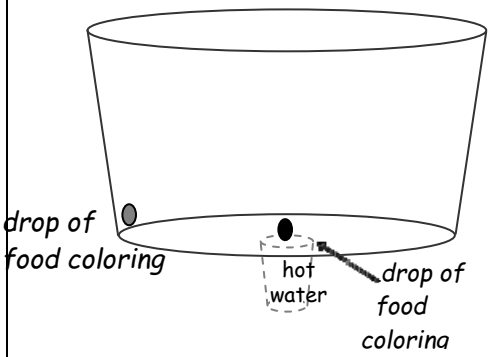
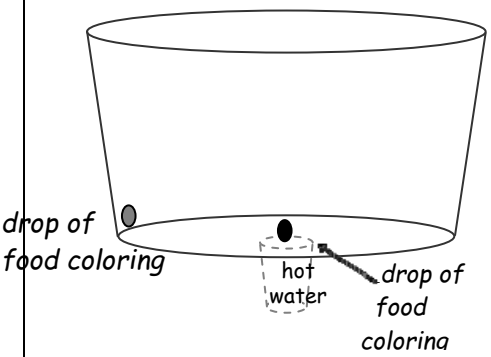
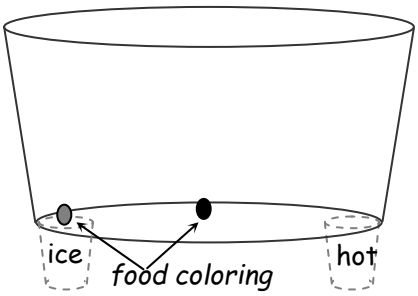
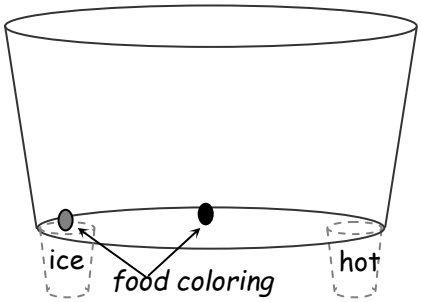
Convection occurs inside the earth (in the mantle) and helps drive plate tectonic motion

Some things to think about
When freshwater from a river flows into the ocean, do you think the freshwater flows to the bottom, stays near the top, or do fresh and salt water mix together quickly?

How is the movement of wind and water around the earth similar? Why do you think this is so?

True or false: Hadley cells and the movement of tectonic plates have nothing in common. Why or why not?

RECORD (draw and describe) YOUR PREDICTIONS AND OBSERVATIONS

	Prediction	Observation
Part (1)		
Part (2)		
Part (3)		

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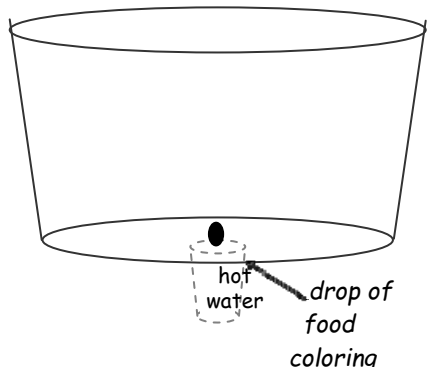
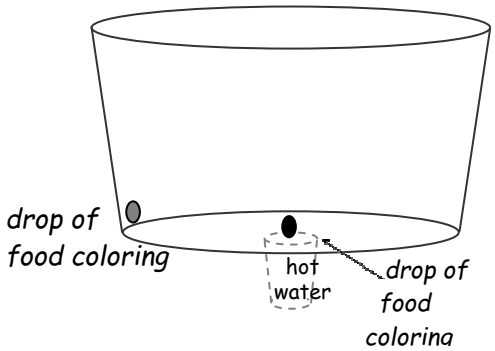
Part (1)		
Part (2)		
Part (3)