Lab: Convection Causes Wind

name: _____

Pre-Lab Questions

1. Convection, conduction, and radiation are the three ways that _____ _____.

2. Match the term with its definition.

_____ conduction	A. the transfer of heat by infrared waves
_____ convection	B. the transfer of heat by touching
_____ radiation	C. the transfer of heat in a fluid that rises

3. If one beaker contains 100 ml of cold water, and another contains 100 ml of hot water, which beaker contains more water molecules?

4. Which water would have the higher mass? Which one would have the higher density?

5. As you open the refrigerator door, what happens to the air inside?

   A. The cold air escapes from the top, rising toward the ceiling.
   B. The cold air stays in the fridge, no matter how long you stand there.
   C. The cold air escapes from the bottom, sinking toward the floor.

Introduction

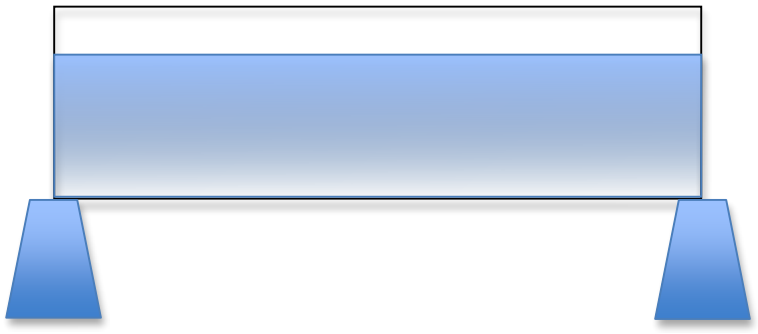
Conduction and radiation are both important in Earth systems, however the focus of this activity will be convection. Convection is a driving force in atmospheric circulation, distributing heat and moisture throughout the world.

Purpose:
1. To observe convection as it happens in a fluid.
2. To realize how density differences within a fluid cause convection.
3. To recognize the role that convection plays in the development of winds.

Materials: a clear plastic box, 5 Styrofoam cups, 4 pieces of cardboard, red colored pencil, blue colored pencil

Part A

1. With one hand under each end of the box, fill it with cool tap water to within an inch from the top. Set the box onto the cups and squares as shown below. Let the water become calm.



2. Ask Mr. Benson to place 3 spots of red food coloring onto the bottom of the box as shown in the diagram on the previous page.

3. Fill one cup with hot water, and then carefully position it beneath the middle spot.

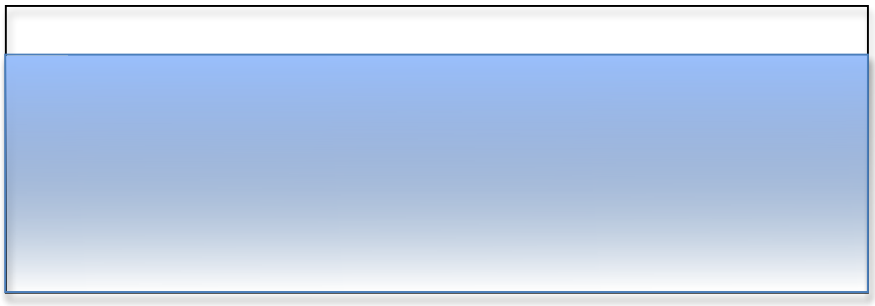
4. Get down so that the box is at eye level, and observe what happens to all three spots over the next 5 minutes. Record your observation here: _____

_____

_____

5. Use the red colored pencil to sketch what you observed happening on the diagram below.

6. With one hand under each end of the box, carry it to the sink, and empty it. Begin part B.



Part B

1. Refill the box with cool tap water and place it onto the cups and cardboard squares as you did in part A. Have Mr. Benson place a spots of red food coloring near one end of the box as shown below. Slide the cup of hot water beneath the spot.

2. Ask Mr. Benson for a blue ice cube. Carefully set it into the water as shown below.

3. Observe the box from eye level for 3-5 minutes. Use your red and blue pencils to sketch what you observed in the diagram below. Use arrow to indicate flow directions.

Follow-Up Questions (due at the start of class tomorrow)

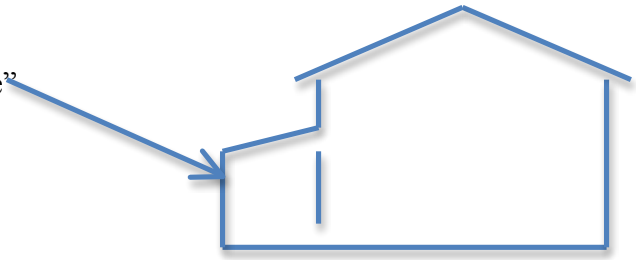
1. Throughout the lab, what effect did the cups of hot water have on **the density** of the water directly above them? Circle one.

The density of the water above the cups was decreased by heat from the cups below.

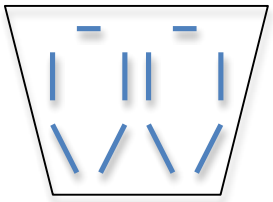
The density of the water above the cups was increased by heat from the cups below.

2. What happened to the water directly above the cups of hot water as a result of this change?

3. The house pictured here has a glass "sun space" attached to its south side. Vents allow air to flow between the house and the sun space. Put several arrows on the diagram to show the direction air would flow as the air in the sun space is warmed by the Sun.



4. You may have noticed convection cells in a pot of boiling macaroni. Put arrows on the dashed lines to show the direction of the convection cells in the pot of boiling water. The hottest part of the burner is beneath the center of the pot.



5. In part B of your lab, why did the cold blue water (from the melting ice) sink?

6. Look at figure 12 and 13 on pages 543-544 (honors fig. 18.18 on p. 540) and read the captions. Why is the island hotter than the surrounding water? (Hint: Think about the "Heating Land and Water Lab" earlier this fall.)

7. What is the air above the island doing to cause the island to become an area of low pressure? Circle one . . .

It is rising. It is sinking.

8. Does this pressure difference cause the wind to blow toward the island or away from it?

9. Why does wind blow in from the sea during the day? Circle one.

Land heats up faster than water, so air over the land is sinking during the day.

Land heats up slower than water, so air over the land is rising during the day.

Land heats up faster than water, so air over the land is rising during the day.

10. Why does the wind blows from the land toward the sea at night.

Water cools off faster than land, so air over the water is sinking during the night.

Water cools off slower than land, so air over the water is rising during the night.

Water cools off faster than land, so air over the water is rising during the night.

11. A "monsoon effect" may happen in the summer as air over a continent becomes much warmer than the air over the ocean. Fill in the blanks in the following statement, choosing from these words: toward, high, away from, sink, low, rise

As air over the continent becomes hotter, it will begin to _____ .

This causes _____ pressure to develop over the land.

The flow of air will be _____ the center of the continent.

12. Which region in our atmosphere is heated most intensely by the Sun? Circle one.

A. the polar region B. the mid-latitudes (45 degrees north and south) C. the equatorial region

13. If the Earth's surface were covered by water, and did not rotate, heating of the atmosphere would cause convection cells as shown in figure 9 on page 540 (honors 535). As air near the equator receives more heat and starts to rise, what moves into replace the rising air?

14. In reality, circulation in the atmosphere is more like what is shown on page 541 (honors p. 538). Explain why.

15. Number the following phrases to show the correct sequence of events.

_____ wind (movement of air from an area of higher pressure to lower pressure)
_____ convection (warm air rising)
_____ uneven heating (some places get hotter than others)
_____ area of low pressure develops