Name: _____ Period: _____

Conduction, Convection & Radiation Lab Activities

Background:

Heat is a form of energy. Heat energy moves from an area of high temperature to an area of comparatively lower temperature. Conduction is the process of moving heat (or electricity) from one place to another without moving the material that carries the heat. Heat makes liquids like water, Earth's mantle and gases like the atmosphere less dense. This means that warm air rises in the atmosphere because it is less dense than cooler air. As the warm air or warm liquids rise, they cool down. Cooler air and cooler liquids sink to the bottom. As a result, alternate heating and cooling cycles of the mantle and the atmosphere create convection currents which exist in an endless circular stream. These are examples of heat transfer. Heat transfer also occurs due to thermal radiation. Thermal radiation is the process of giving off heat from a heated surface. Some substances are more radiant than others. In these activities, you will be conducting experiments that will help you visualize conduction, convection or radiation.

Prelab:

1. Draw, label and color a model of the convection currents in Earth's mantle in the space below.

2. Draw, label and color a model of the convection currents in Earth's atmosphere in the space below.

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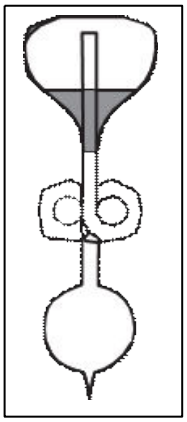
DAY ONE CCR (Conduction, Convection & Radiation) LAB

Directions: You may do the experiments in any order. The experiments are designed to demonstrate at least one of Earth's heat transfer mechanisms: conduction, convection or radiation. Do the experiments according to the procedure and answer the questions after each one.

Experiment #1: The hand boiler

A hand boiler is a completely closed glass container made of two bulbs connected by a looped piece of tubing. Within the hand boiler is an ethanol-dye solution. You can perform a simple heat transfer experiment on this system using your hand.



Materials: **hand boiler**

Background: The liquid inside the Hand Boiler does not actually boil. The "boiling" is caused by the relationship between the temperature and pressure of a gas. As the temperature of a gas in a closed container rises, the pressure also rises. The molecules are moving faster in the warmer gas. There must be a temperature (and pressure) difference between the two large chambers for the liquid to move. Heating and cooling cause changes in the properties of matter. Atoms and molecules are perpetually in motion. Increased temperature means greater average energy of motion, so most substances expand when heated.

Procedure:

1. Hold the hand boiler by placing it in your palm and cupping your fingers around it.
2. Turn the hand boiler over and repeat
3. Make observations & answer the questions below. Note: CCR is conduction, convection or radiation

EXPERIMENT #1 TABLE:

OBERVATIONS	Which CCR?	Explain

EXPERIMENT #2: Colored Ice Cubes

Materials: **colored ice cube** **beaker** **water (about 35-40^{o}C)** **thermometer**

Procedure:

1 Obtain an ice cube that has been strongly dyed with food coloring.
2. Fill the beaker ¾ full of warm, fresh water, approximately 35°C - 40°C
3. Gently place the ice cube in the beaker. Keep the beaker and water as still as possible.
4. Make observations every minute for 5 minutes. Write a detailed description of your observations.
5. Measure the temperature at the surface & at the bottom of the mixture. Record the temperatures in the data table after 5 minutes.
6. Empty & rinse the beaker for the next person. Fill out the data table on the next page.

Data table for Experiment #2

OBSERVATIONS	
@ 1 minute	
@ 2 minutes	
@ 3 minutes	
@ 4 minutes	
@ 5 minutes	
Surface Temperature °C at 5 minutes	
Bottom Temperature °C at 5 minutes	
Which CCR is this?	

QUESTION:

1. EXPLAIN & JUSTIFY using several sentences what the results mean AND why the CCR you chose is the right answer to what this experiment shows.

2. Explain how the density of warm water is different from cold water. How does the density affect where the cool water was found compared to where the warm water was?

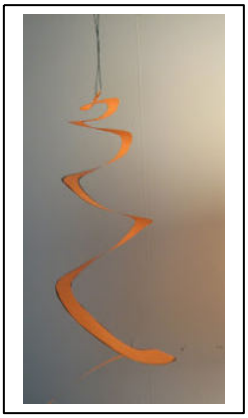
Experiment #3: The Spinner

Materials: hot plate – construction paper – string – pen – hole punch - scissors

Procedure:

1. Plug in the hot plate to warm it up.

2. Use a pen to create a spiral design on construction paper. Cut a spiral out of construction paper and add a string so you can hold it. You can use the hole punch if needed to make a place for the string.
3. Hold the spiral above the hot plate and close enough that it is in range of the heat.
4. Make observations below and answer the questions that follow.



Observations

Questions:

1. What kind of heat transfer, CC or R, is the heat that is put out by the hot plate that you can feel by placing your hand close to the hot plate?

2. What kind of heat transfer, CC or R, is happening to the spiral based on the behavior of the spiral that you observed?

3. Explain the density of warm air versus cool or cold air.

4. How does the density and heat or coolness of the air (atmosphere) affect movement of the air?

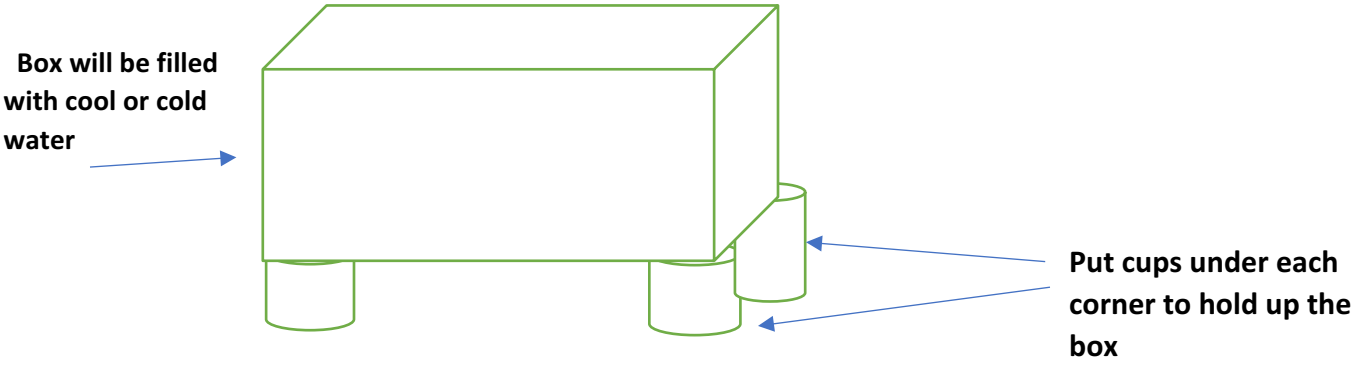
Name: _____ Period: _____

DAY TWO CCR (Conduction, Convection & Radiation) LAB

Directions: You may do the experiments in any order. The experiments are designed to demonstrate at least one of Earth's heat transfer mechanisms: conduction, convection or radiation. Do the experiments according to the procedure and answer the questions after each one.

Experiment #4: Magnificent Moving Water

Materials: rectangular plastic container – cool/cold water – 5 plastic/styrofoam cups – red food coloring – another color of food coloring – 2 pipets for the food coloring – hot plate for warm/hot water



Procedure:

1. Make sure that hot plate is heating a beaker of hot water.
2. Add cool tap water to the box and fill the box half to ¾ full (If box does not have water). Add ice if available to cool the water down.
3. Add red food coloring with the pipet to the center part of the water and a different color of food coloring to each side of the box.
4. Pour hot water into Styrofoam cup and place it under the red food coloring toward the center of the box after all the ice has melted.
5. Someone on your team must continue to watch the water until a change happens. Call all team members over to make observations when the change occurs. Fill out the data table and answer the questions.

OBSERVATIONS	Which CCR?	EXPLAIN

Question:

Name 2 places on Earth where this CCR is known to exist.

1.

2.

Experiment #5: Glorious Copper

Materials: Hot plate copper beaker tongs

Procedure:

1. If the copper is not on the hot plate, place it there.
2. After the copper has been heating for at least 5 to 10 minutes, pick it up with the beaker tongs and wave your hand close to the metal but not touching it. DO NOT TOUCH THE COPPER WITH YOUR HANDS AFTER IT HAS BEEN HEATING. Make observations and fill out the table.

OBSERVATIONS	CCR	EXPLAIN

Experiment #6: The Fireproof Balloon

Materials: 2 Balloons - candle with a way to light it - penny - water - balloon pump if available – paper towel

Procedure:

1. Do this on a paper towel. Light a candle and drip a few drops on a penny. While the wax is still hot, plant the candle in the wax so that it will stand on its own.
2. Blow up a balloon, but not quite all the way. Use a balloon pump if available.
3. Hold the balloon over the candle. Make observations.
4. Blow up a second balloon, but not quite all to way. Add enough water to fill the balloon about one third full.
5. Hold the balloon where the water is over the candle flame. Make observations. Explain.

Balloon #1 observations	
Balloon #2 observations	
Which CCR?	
Explain why	

Experiment #7:

Materials: 2 small flasks with balloons covering the opening –bowl of hot water – bowl of cold water

1. The flasks should not have anything inside except air. Place one in a bowl with cold water that has been cooled with ice if available. Place the other in a bowl that has hot water. Make observations & explain.

OBSERVATIONS	
CCR?	
EXPLAIN	