Heat Transfer
Lesson Two

Investigating Heat Convection

Standard 6.2.3
Plan and carry out an investigation to determine the relationship between temperature, the amount of heat transferred, and the change of average particle motion in various types or amounts of matter. Emphasize recording and evaluating date, and communicating the results of the investigation.

Scientific Practice:

- Plan and Carry out an investigation

Cross Cutting Concepts:

- Cause and Effect
- Flow of energy and matter

A. Literary Reading

Materials:

1. Literacy Reading—Heat convection
2. Convection Heat Transfer Examples

Directions

1. Review ***Heat Energy***
2. Read just about ***Heat Convection***
3. Discuss what convection means by giving some examples. Read the examples of heat convection.
4. You may want to do the baby jar experiment by putting blue cold water in a baby jar on top and red hot water in a baby jar on the bottom and see the liquids change places.

B. Experiments

1. **Paper Spinner Experiment**

a. Materials

- Spiral paper
- String
- Heating Unit

b. Directions:
    1. Follow the directions on the activity sheet.
    2. Answer the questions as you go.

c. Discussion:
    1. Discuss the results of the experiment.
    2. Communicate your ideas in your journal

2. Investigating the Weight of Water When it is Hot and Cold

a. Materials:
- Worksheet, "Investigating Convection Currents"
- Clear plastic cups
- Thermometers
- Ice cold water
- Blue food coloring
- Room temperature water
- Hot water
- Red food coloring
- Paper towels
- Small syringe
- Worksheet "Investigating Convection Currents"

b. Directions:
    3. Follow the directions on the activity sheet.
    4. Answer the questions as you go.

c. Discussion:
    3. Discuss the results of the experiment.
    4. Communicate your ideas in your journal

3. When Hot and Cold Meet Warm— Convection

a. Materials:
- Worksheet, "When Hot and Cold Meet Warm"
- 2 Baby food jars
- Transparent container about the size of a small fish aquarium
- Ice water dyed blue
- Boiling water dyed red
- Aluminum foil
- Rubber bands

b. Directions:
    1. Follow the directions on the activity sheet.
    2. Answer the questions as you go.
c. Discussion:
    1. Discuss the results of the experiment.
    2. Communicate your ideas in your journal.

Heat Transfer

Heat Energy

Particles that make up substances are always moving and always have energy. This energy can be transferred from one object to another by three means—*conduction, convection,* and *radiation.*

There is a difference between heat and temperature. *Heat* is the energy that the object has because the particles are moving. *Temperature* is a way of measuring heat energy. Two scales that are commonly used to measure heat are the *metric system* and the *standard system.* The metric system uses *Celsius* and the standard system uses *Fahrenheit* to measure heat. The measurement of temperature gives the average amount of energy contained in the substance.

Heat always travels from hotter to cooler objects. It may seem that when you are holding an ice cube, the ice cube is causing your hand to feel colder. However, the real physics behind this heat transference is that the feeling of coldness in your hand is caused by the heat flowing away from your hand and into the ice cube. The energy from the faster moving (hotter) particles transfer to the slower moving (colder) particles. The transfer of energy goes on until all the particles in both objects are all moving at about the same speed. When the amount of heat energy of each object is the same, both objects will have the same temperature.

Convection

Heat energy transferred by the movement of a liquid or gas is called *convection.* When particles are heated, they move faster, move apart from each other (expand), become less dense (lighter in weight) and the particles rise. As the heated substance rises, the cooler, heavier substance moves down. As a liquid or gas cools, the particles move slower, move in toward each other (contract), become more dense (heavier in weight) and the particles sink. These currents exchange heat through this movement.

This movement of heating, expanding, cooling, contracting, and sinking is a continuous one. An example is to observe the amount of wind in the early morning compared to the afternoon. As air heats up during the day, the hot air rises. Cold air is heavy and comes in and takes the place of the rising hot air and causes wind. Wind is an example of convection process in motion.

You can observe convection in a simple experiment. Get two baby food jars. Fill one with hot water and a drop of red food coloring. Fill the other with cold water and a drop of blue food coloring. Place a card over the mouth of the cold water jar and turn it upside down on the top of the warm water jar. Carefully pull out the card. You should see warm, red water rising and cold blue water sinking.

Examples of everyday convection heat transfer are hot air balloons, air currents, ocean currents, continental drift, hot air near the ceiling and the cooler air near the floor, a pinwheel over a heating unit, convection ovens for better cooking, dust devils, and even tornadoes.

Convection

Transfer of heat in liquids and gasses through currents

Water in a heated pot begins to boil

A bird takes advantage of rising warm air by catching an updraft

Cool air sinks to the ground on a warm night

A swimmer is caught in a current of cold water and is pulled under

Air is warmer near the ceiling than the floor

Name _____

Paper Spinner Experiment

1. There is a spiral on a string. Hang it in the air. Write what you see happening.

_____

_____

2. Now put the spiral over a heat source. Write what you see happening.

_____

_____

3. Write a conclusion shy the spiral is doing this.

_____

_____

4. Explain what happens when air is heated.

_____

_____

5. Explain why heated air does this.

_____

_____

6. What is taking the place of the rising hot air?

_____

_____

7. What are examples of rising air around us?

_____

_____

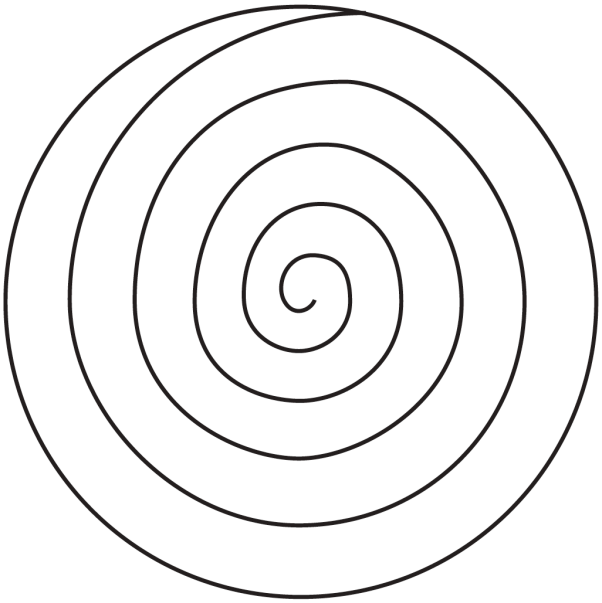
Paper Spinner Direction

You will need:

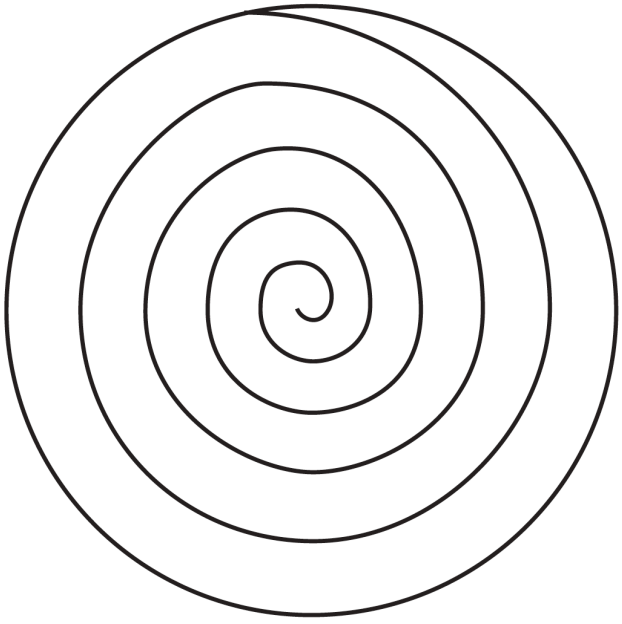
One spiral, Scissors, A short piece of cotton string, A hot plate

1. Cut out the appropriate circle, then cut along the spiral.
2. Carefully cut a slit in the mark in the center.
3. Put the piece of string through the slit and knot the end to hold it in place.
4. Turn on the heat source.
5. Hold the string of the spinner above the heat source and watch it turn.

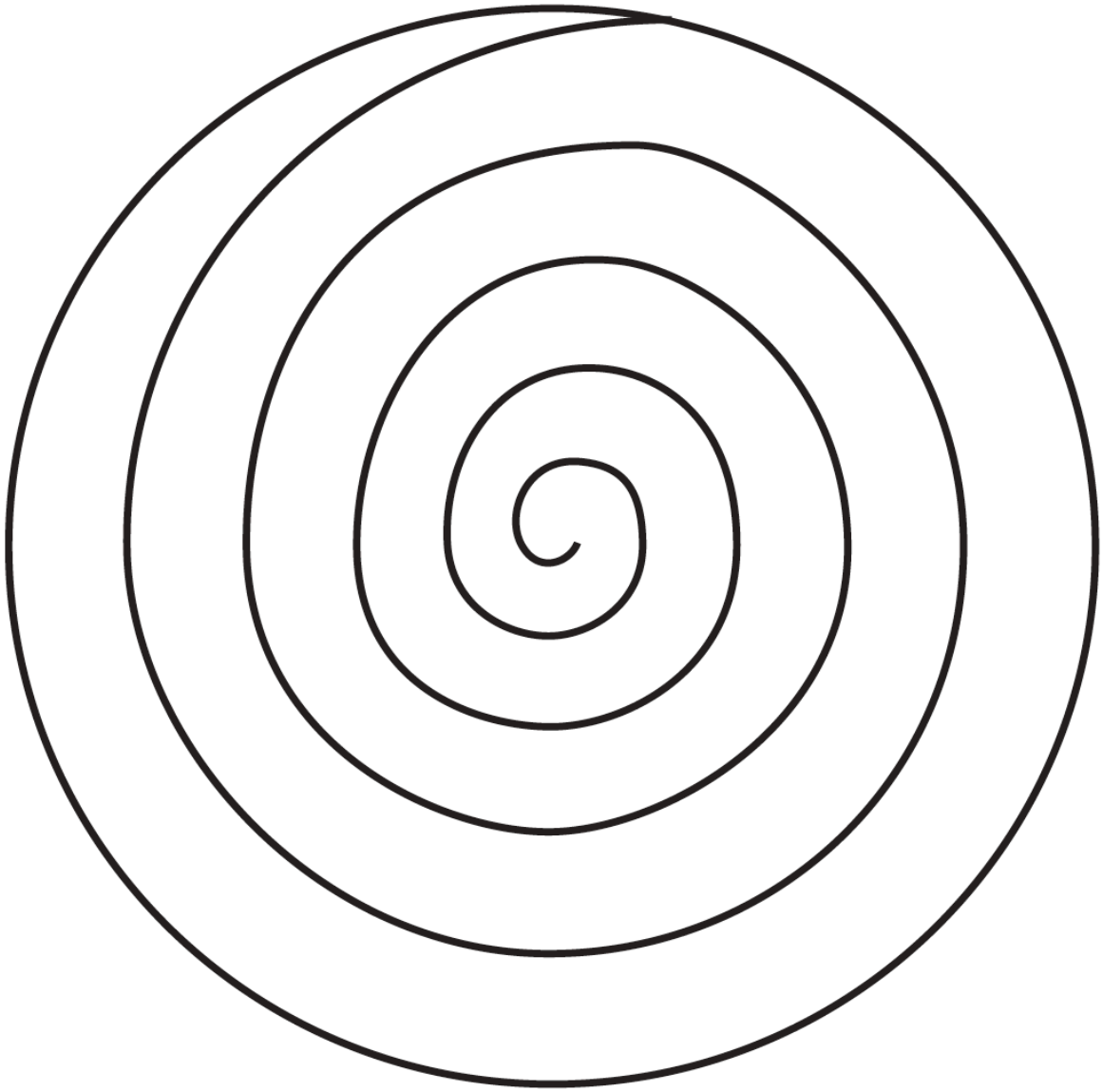
Right-Handed Spinner



Left-Handed Spinner



Big Spinner



Name _____

Investigating The Weight of Water When it is Hot and Cold

I. Experiment One

1. Put the hot water color at the top of one of the room temperature water cups.
2. Write down what you see happening.

_____

_____

3. Put the cold-water color at the bottom of one of the room temperature water cups.
4. Write down what you see happening.

_____

_____

II. Experiment Two

1. Put the cold-water color at the bottom of one of the room temperature water cups.
2. Put the hot water color at the top of the same room temperature water cup.
3. Write down what you see happening.

_____

_____

4. Write down your conclusion of what you discovered after doing experiments One and Two.

_____

_____

III. Experiment Three

1. Put the hot water color at the bottom of the cup in the room temperature water.
2. Write down what you see happening.

_____

_____

3. Put the cold-water color at the top of one of the room temperature water cups.
4. Write down what you see happening.

_____

_____

IV. Experiment Four

1. Put the hot water color at the bottom of one of the room temperature water cups.
2. Put the cold-water color at the top of the same room temperature water cup.
3. Write down what you see happening.

_____

_____

5. Write your conclusion of what you discovered after doing experiments Three and Four.

_____

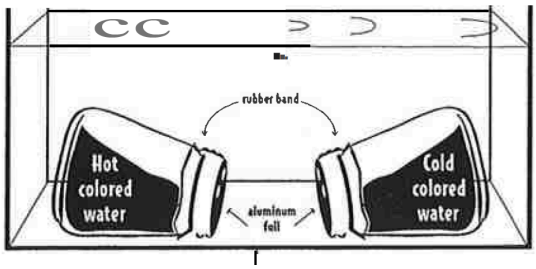
_____

Name _____

When Hot and Cold Meet Warm

Instructions:

1. Fill the transparent container with room temperature water.
2. Fill one baby food jar with boiling water and add three drops of red food coloring. Cover the jar with aluminum foil and put a rubber band around the neck.
4. Gently lower it into the container, turning it on its side.



5. Puncture the aluminum foil in the middle and again near the edge with a pencil point so the colored hot water can flow out. If the water doesn't flow out, you may need to put the pencil into one of the holes to release any trapped air bubbles.
6. Fill the other baby food jar with ice water and add three drops of blue food coloring. Cover the bottle with aluminum foil and put a rubber band around the neck.
7. Gently lower it into the container, turning it on its side.
8. Puncture the aluminum foil in the middle and again near the edge with a pencil point so the colored hot water can flow out. If the water doesn't flow out, you may need to put the pencil into one of the holes to release any trapped air bubbles.
9. Answer the questions on below.

1. What did you notice happened to the hot water from the baby food jar?

_____

_____

2. Why do you think this happened?

_____

_____

3. What do you notice happened to the cold water from the baby food jar?

_____

_____

4. Why do you think this happened?

_____

_____

5. What are some other examples where hot fluids rise and cold fluids sink?

_____

_____

6. What do you think will eventually happen in the container if the jars are left in it for an hour?

_____

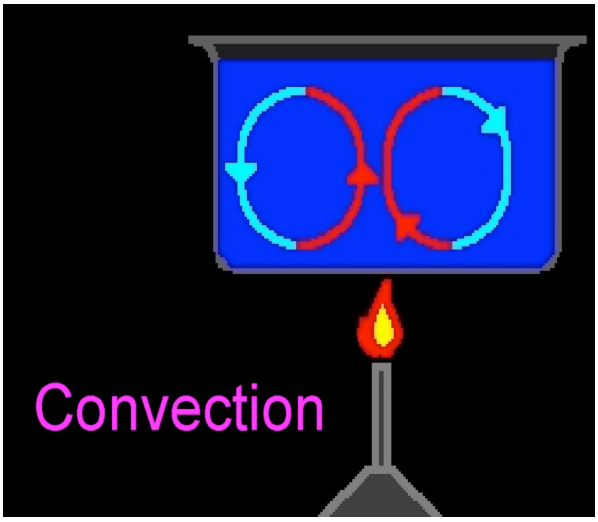
_____

7. What is another way you could demonstrate this process of convection?

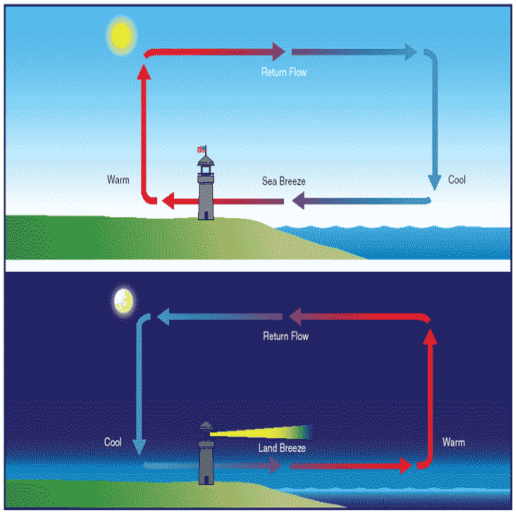
_____

_____

A Convection Current



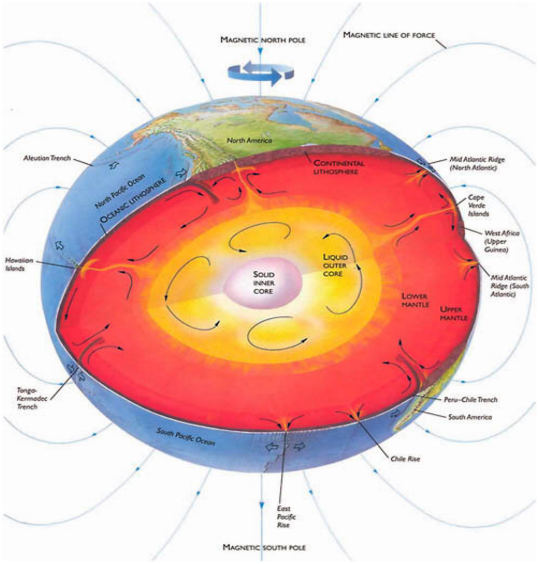
Daytime and Nighttime Convection Currents

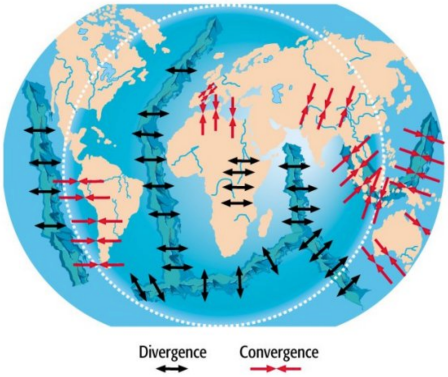


Ocean Convection Currents

Convection currents in the Earth

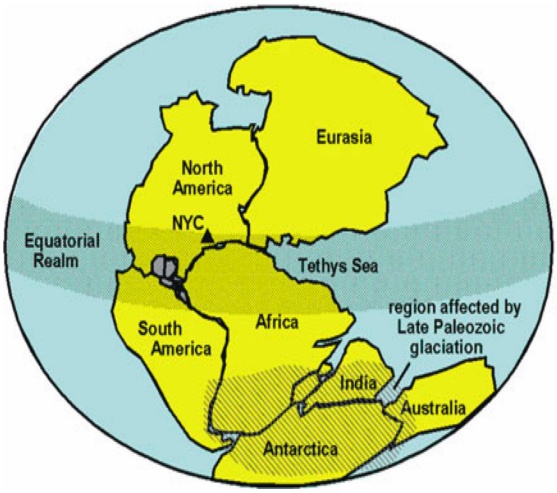
Cause Continents to Move





<u>Example of Continental Drift</u>

Pangaea Over 245 Million Years Ago



Pangaea to Present Day