

Understanding the three types of Thermal Energy Transfer

Lab One: Convection

Grab three glass beakers. Fill the two beakers with tap water and another beaker with cold ice water. Place one of the tap water beakers onto a hot plate that is turned on high.

Get a stopwatch ready.

While the hot plate is warming up a beaker of water, add 5 drops of blue food coloring to the ice-cold water. Observe how the food coloring disperses and use the stopwatch to time how long the food coloring takes to disperse before the water is completely blue.



1. Ice Water Time:

2. Ice Water Observation:

Get your timer ready. After your beaker on the hot plate is warm or hot to the touch, but not boiling, time how long it takes for 5 drops of red food coloring to disperse.

3. Hot Water Time:

4. What was the time difference between the red and blue food colorings?

Turn off your hot plate.

Now take a dropper full of the red-colored hot water, if the dye didn't completely mix stir it around using one of the droppers, and add drops of this cold blue ice water to the top of the tap water beaker.

5. What happened with the cold water?

Now take a dropper full of the red-colored hot water and place the dropper tip all the way to the bottom of the first beaker and squeeze the water slowly.

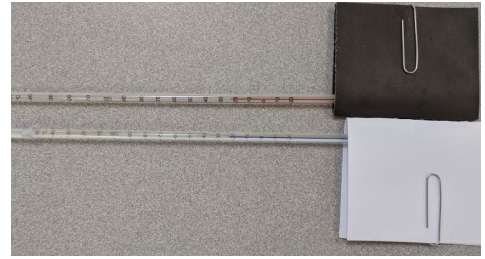
6. What happened with the hot water?

This lab demonstrates how heat is transferred via **convection**.

7. Based on your observations and completion of this lab, discuss with your lab partners what convection is and how it transfers heat. Write some notes and ideas below in the space provided.

Lab two: Radiation

Fold a piece of black paper or cloth in half. Do the same for a white piece of paper or cloth. Place a thermometer bulb inside each of the papers or cloth. Slide a lamp over top of the thermometers at about 6 inches above the thermometers. Turn the lamp on and record the temperature every 30 seconds for 3 minutes. It should look something like the image below.



| Time | Temperature on Black Paper | Temperature on White Paper |
|-----------------------|----------------------------|----------------------------|
| 0:00 or Starting Time | | |
| 0:30 | | |
| 1:00 | | |
| 1:30 | | |
| 2:00 | | |
| 2:30 | | |
| 3:00 | | |

5. Which paper/cloth heated up the quickest?
6. How did the heat from the lamp get to the paper, to begin with?
7. Explain the science to the best of your current knowledge behind this experiment.

This type of thermal energy is called **radiation**.

Lab three: Conduction

Fold some tin foil into a strip about an inch wide and 10 inches long. Place the tin foil onto the ring of a ring stand folding some aluminum foil around each ring so that the foil doesn't fall. Evenly place 6 chocolate chips along the strip of tin foil. Get your stopwatch ready. Now lower the ring so that one side of the foil sits just above a lit candle. Your set up should look like the picture. Time how long it takes before the chocolate chip begins to melt. Record your data below.



| Chip | Time |
|--------|------|
| First | |
| Second | |
| Third | |
| Fourth | |
| Fifth | |
| Sixth | |

8. Describe how the heat got to each chocolate chip?

This transfer of thermal energy is called **conduction**.

Teacher's Reflection, Suggestions, and Procedures

1. In this lab, students are going to learn and experiment with the three types of heat transfer. By the time students are finished with all three experiments and the lab sheet, they have a good understanding of convection, conduction, and radiation.
2. Procedure:
 - a. I set my labs up in the morning. Each group will need a hot plate, ring stand, 6 chocolate chips, a strip of tin foil, 3 beakers, access to water, a heat lamp, red and blue food coloring, timers, ice or cold/chilled water, 2 paper clips, 2 thermometers, a dropper, and a tea candle.
 - b. Not all classrooms have ring stands so before I had ring stands I just used two soup cans and raised the candle up using something non-flammable underneath. Ring stands work great for this as you can easily adjust the height.
 - c. I only had access to two heat lamps so I placed the lamps in the back and had groups take turns going back to that lab.
 - d. The order in which you do the labs don't matter. For example, because I lacked enough heat lamps I had groups start warming up their beakers in lab1 while they did the radiation experiment.
 - e. Make sure you warn students that heat lamps are hot. I never had a student get burned "yet", but I still warn them as they are really hot.
 - f. Because the thermometers are heated past room temperature during the experiment, it is pretty important for each group to have their own. If they don't, send two groups to the heat lamps to do the experiment. Make sure you have enough thermometers for however many times the experiment will be run.
 - g. I divided up my groups into 3 or 4 students as larger groups allow one or two students to do nothing. I have 8 hot plates so I just make sure I had 8 groups.
 - h. Alternative: If you don't have enough lab materials, you can set the experiments up at different tables and give 10 minutes per experiment and then have the students rotate.

