

# Heat Transfer: Radiation

## Safety Precautions

Handle glass thermometers carefully

## Material List (per group)

1 timing device (stopwatch)  
white and black construction paper  
tape or glue

3 plastic pop bottles of equal size  
3 thermometers  
radiant heat source (preferably the sun)

## Advanced Preparation

Your teacher will already have enough room temperature water for this experiment.

## Procedure

1. Fully cover the outside of a bottle with black construction paper.
2. Fully cover the outside of another bottle with white construction paper.
3. Leave a third bottle clear.
4. Fill all three bottles equally with room temperature water.
5. Record the temperature of the water for each bottle.
6. Place the bottles in the same location, exposing them to the sun.
7. Predict what will happen to the temperature of the water in each of the bottles.
8. Record your predictions in your notebook.
9. Take the temperature of the three bottles: 10 trials at two minute intervals. Record the temperatures in a suitable table in your notebooks. **Do not leave the thermometers sitting in the bottles between temperature readings.**

## Analysis Questions

1. Construct a line graph whose horizontal axis (x-axis) records the exposure time to radiant source and whose vertical axis (y-axis) records the internal temperature of the bottle. Plot and compare.
2. Analyse and share the results of your findings. Which bottle registered the highest internal temperature? Lowest temperature? Explain the process of radiation as it applied to this investigation.

## **Relating Science and Technology to the World Outside**

1. Explain why the sun is considered a "radiant" energy source. Can the sun play an integral part in convectional or conductive heating? Justify your reasoning.
2. Describe how the water cycle is a process of energy transfer involving convection and radiation.
3. Give five examples of heat transfer by radiation.
4. Use the Particle Theory to explain the effect of the sun as a "radiant" energy source on human skin.
5. Examine the appliances in your home. Which provide energy transfer through radiation?

## **Culminating Task Considerations**

Select a material whose colour will generate optimum heat transfer through radiation. Consideration must be given to the placement of windows and skylights. Record all observations, skills, facts, and questions during the investigation. There is a direct connection between this subtask and the culminating task. Having a thorough notebook will assist you in the end. You may wish to consult with your group and/or teacher regarding verification or clarification.

# Heat And Volume

## Safety Cautions

- Safety goggles must be worn.
- All work surfaces should be cleared.
- Students should be standing when working with heat sources.

## Material List (per group)

flask	modeling clay
bucket	narrow white drinking straws
water mixed with food colouring	ice water

## Procedure

1. Fill the flask 3/4 full with coloured water.
2. Mold the plasticine around the straw, insert the straw into the flask, and fit the plasticine over the opening of the flask.
3. Note the level of water in the straw.
4. Warm the flask by placing your hands around it for several minutes. Be sure to note what happens to liquid in the straw.
5. Cool the flask in a bucket of ice water. Note what happens to the level of the liquid in the straw.
6. Draw three diagrams illustrating what happened to the level of water as noted in steps 3, 4, and 5.

## Analysis

1. What happens to liquids when they are heated? Cooled?
2. Could this apparatus be used as a thermometer? Explain why/why not.
3. Extend the knowledge gained in this investigation to explain how heat affects the volume of solids and gasses. Keep in mind what particle theory states about liquids and gasses.

## Relating Science and Technology to the World Outside

1. Define the words "expand" and "contract." State which process requires the addition of energy and which the removal of energy.
2. Predict what will expand more when heated - a solid, a liquid, or a gas. Write a short report explaining the reasons for your prediction.
3. When laying rail down on a railway track, workers leave a considerable gap between the different sections of rail. Write a short report explaining why this is done. Find two other examples where this gap exists.

## **Culminating Task Considerations**

Think of how the material involved in the construction of your building will need to expand and contract. (For example, wood flooring expands and contracts as heat is added or removed.) How would this affect the installation of your flooring? What other material in your remodeling will react this way? Make notes for yourself based on the knowledge you have learned in this investigation. List any questions regarding expansion and contraction you will need answered to help you in completing the culminating task.