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Heat Radiation Apparatus
#HEATRAD02

Warning:

- **Not a toy; use only in a laboratory or educational setting.**
- **California Proposition 65 Warning: This product may contain chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.**

Introduction

Though they are used interchangeably in every day speech, temperature and heat are not quite the same thing. **Temperature** measures the kinetic energy of the molecules in an object or system, while **heat**, on the other hand, is the transfer of thermal energy from a hot region to a cold one. Heat uses three processes to transfer energy: conduction, convection, and radiation. **Conduction** can be described as the transfer of thermal energy between two objects that are in direct physical contact with each other, and **convection** can be described as the flow of thermal energy within a liquid or gas. Unlike conduction and convection, however, **radiation** does not require any contact between the objects undergoing a heat transfer. Radiation can occur in a vacuum. For example, the sun radiates heat to warm the Earth. This energy is known as thermal radiation, which is a form of electromagnetic radiation. Infrared light is the type of light on the electromagnetic spectrum that carries this form of energy.

This kit will help you explore heat, radiation, and the effects that color and distance have on an objects ability to absorb and radiate heat.

Experiments

The Effect of Color on Radiation

1. Choose two cups. **(Note:** For the first time that you perform this experiment, we recommend picking the white cup and the black cup. It is interesting to experiment with other colored cups to see how they compare.**)**

2. Set your lamp up so that it is just above your work surface with its lightbulb facing parallel to the surface.
   (To set up your lamp: Screw on reflector cover over the bulb socket. Screw in the bulb. Assemble your support stand. Fasten a boss head clamp to the support rod. Clip your lamp to the stand. Plug in the lamp.**)**

3. Prepare your cups by placing your them 10cm in front of the lamp, fitting them with their covers, waiting until their respective thermometers read the same temperature, and sticking one of them into the cover of each cup.

4. Take note of the starting temperature in each cup, and then turn your lamp on.

5. Record the temperature of each thermometer in one-minute intervals for a period of ten minutes.

6. Turn your lamp off after ten minutes and continue to record temperatures every minute for the next ten minutes.

7. Plot your results on a graph to produce a visual representation of color's effect on radiation. Graphs are available on the following page.

8. Repeat the experiment again with different color combinations.

Radiation Over a Distance

1. Set up your lamp as explained in the first experiment.

2. Make a mark 7cm away from the lamp using a ruler (not included) to keep the distance accurate. Make two other marks at 7cm intervals. You should have three marks in front of your lamp at distances of 7cm, 14cm, and 21cm.

3. Place a cup with a cover on it and a thermometer in the cover on top of the mark closest to the lamp. **(Note:** A black cup is recommended for the first run through with this experiment, but feel free to try other cups. Color isn't being studied here.**)**

4. Note your starting temperature and then turn on your lamp.

5. Heat the cup until it stops raising in temperature (*i.e.* **radiative balance**). Take note of the maximum temperature. By subtracting the starting temperature from the maximum temperature, you will find the value for ΔT_1.

6. Calculate the temperature change for cups on marks two (14cm away) and three (21cm away).

7. Repeat steps #3 through #5 twice, once each for the other marks. Allow time to cool between each repetition.

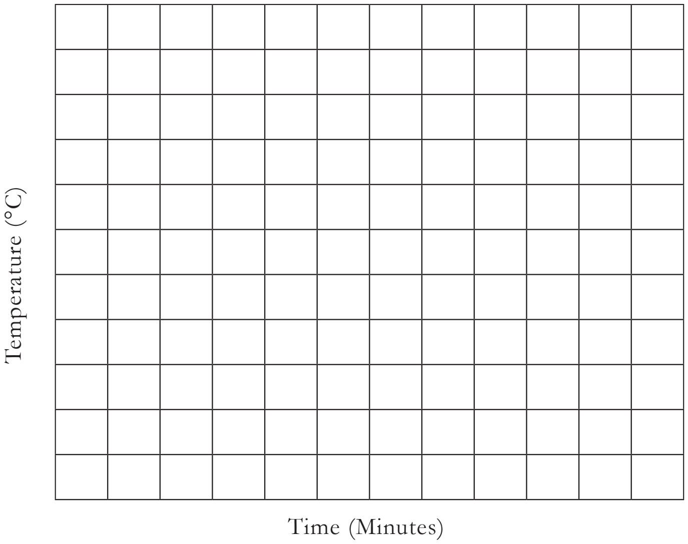
8. Compare your calculated temperature changes with what you found in step #7. Were they accurate predictions?

$$\Delta T_x = \Delta T_1 / d^2$$

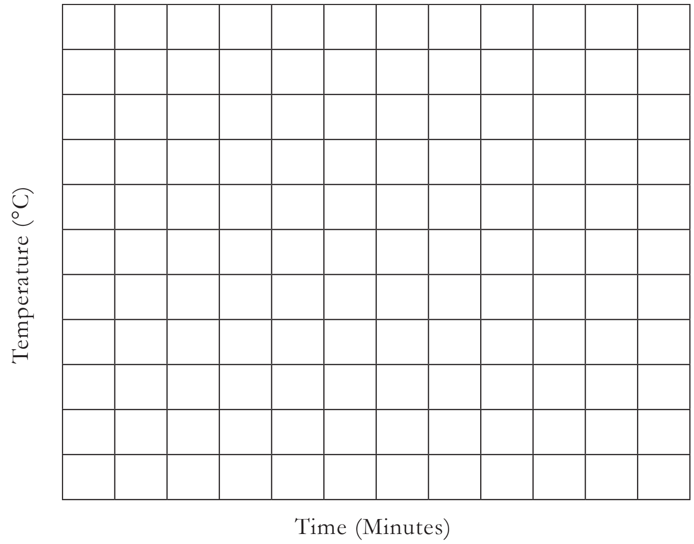
- **ΔT = Change in Temperature (°C)**
- **ΔT_1 = Change in Temperature of Cup on Mark One (°C)**
- **x = Position of Cup (*e.g.* Cup on third mark is 3)**
- **d = Distance (In units equal to the intervals; *i.e.* 7cm = 1 Unit)**

Graphs for Data Recording

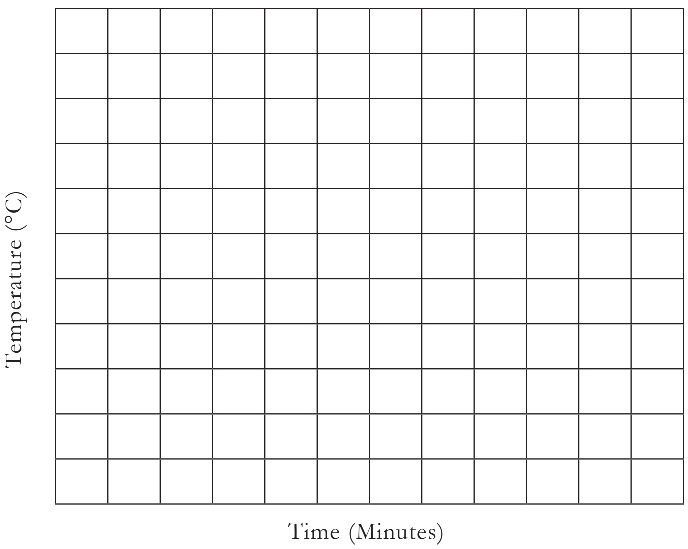
Radiation Comparison



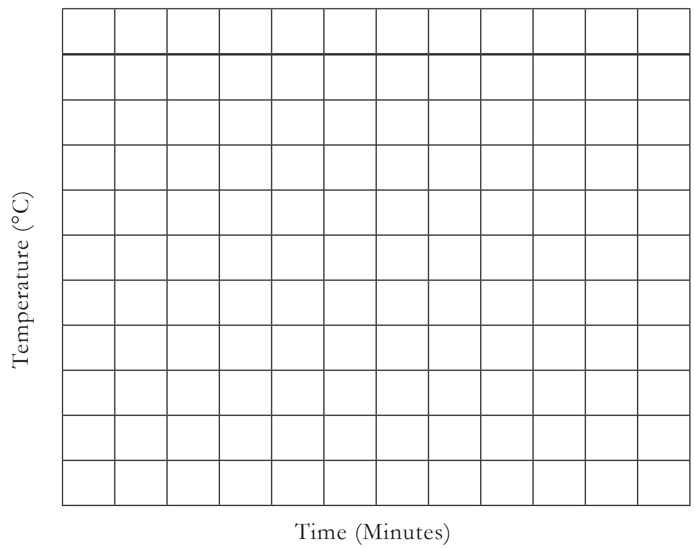
Radiation Comparison



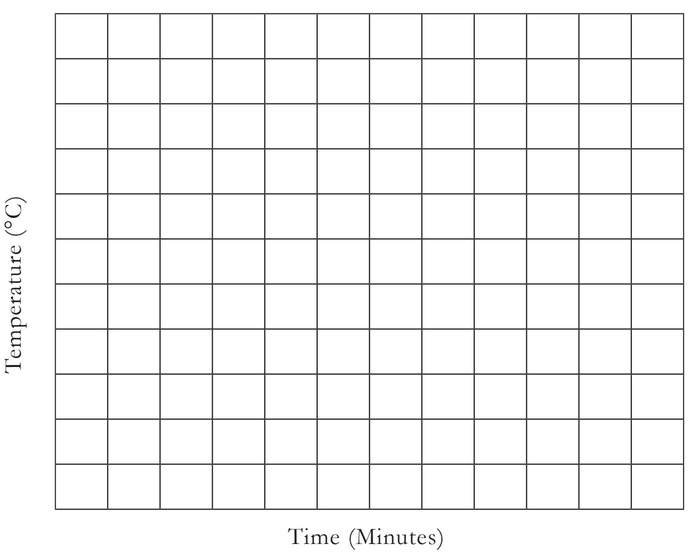
Radiation Comparison



Radiation Comparison



Radiation Comparison



Radiation Comparison