Name _____ Date _____ Per. _____

Black Body Radiation and the Leslie's Cube

Background

All objects emit, radiate, absorb, and reflect electromagnetic energy. Stars are no exception. A Leslie's Cube can demonstrate two properties that stars exhibit: emissivity and absorptivity. A star, like our Sun, is considered a Black Body, which absorbs and emits all wavelengths of electromagnetic radiation. The emissivity and absorptivity depend on the properties of the object, and is a measure of how "good" a radiator or absorber an object is. The Leslie's Cube helps demonstrate the large differences in emissivity and absorptivity of the surface finish of metals. It is a container with four sides finished with different surfaces: shiny black paint, flat black paint, white paint, and polished metal. Filling the Cube with water assures that all surfaces are the same temperature.

To understand how different metal surfaces can emit infrared (or thermal) energy, let's investigate the temperatures of each Leslie's Cube surface. This will help us to better understand the ideas of the absorptivity (absorption) and emissivity (emission) of thermal light energy.

Materials

Leslie's Cube, thermometer, thermal sensors (infrared thermometers), ruler, boiling hot or freezing cold water, data sheet (radiometers optional)

Procedure

1. Predict and rank which of the Leslie's Cube's surfaces will be the hottest and coldest when hot (or cold) water is placed inside. Provide a reason why you made the choices that you made. Record your predictions in Table 1: Predictions.

2. Pour boiling hot (or freezing ice) water into the Leslie's Cube, partially filling it. Measure the temperature of the water inside the cube with the thermometer. Record the water temperature just prior to and after making surface temperature measurements. Enter the measured temperatures in Table 2

3. Place the infrared thermometer about 5 cm in front of each face of the cube and measure the temperature of each face. Be sure to keep the distance of the thermometer from the cube the same for each measurement. Record the temperatures in Table 3 below.

4. Rank your measurements from 1 to 4, with 1 being the hottest measurement and 4 being the coolest in Table 3. Discuss in your group whether your predictions were or were not correct, and why you think the results turned out the way that they did. Record your findings in Table 3.

5. A class discussion will follow so that each group can share their results. After this discussion, answer the questions in the conclusion.

Data

Table 1: Predictions

Metal Side Material	Predict and rank which metal face will be hottest? Coldest? 1 = hottest 4 = coldest	Explain why you ranked each metal side the way you did.
uncoated polished metal		
white painted metal		
flat black painted metal		
shiny black painted metal		

Table 2: Temperature of Water Inside Leslie's Cube

Prior to measuring surface temperatures	$^{\circ}$F
After measuring surface temperatures	$^{\circ}$F

Table 3: Measurements and Observations

Metal Side Material	Measured temperature of metal face ($^{\circ}$F)	Rank which metal faces were actually hottest 1 = hottest 4 = coldest	Explain why or why not you think your predictions matched the actual temperatures measured
uncoated polished metal			
white painted metal			
flat black painted metal			
shiny black painted metal			

Conclusion

1. Did your predictions of the Leslie's Cube's metal faces match the measured values? Explain why or why not.

2. How does the Leslie's Cube demonstrate emissivity?

3. How does the Leslie's Cube demonstrate absorptivity?

4. How is the Leslie's Cube the same as a star?

5. How can the Leslie Cube be used to explain what we know about stars?

6. Add any other ideas or questions you have after this lab here.