Name_____ Period_____ Date_____

CONCEPTUAL PHYSICS **Experiment**

22.5 Heat Transfer: Absorption of Radiant Energy

CANNED HEAT: HEATING UP

Purpose

In this experiment, you will compare the ability of different surfaces to absorb thermal radiation.

Required Equipment and Supplies

heat lamp and base
radiation cans: silver, black, and white
thermometer
access to cold tap water
paper towel
graph paper

Discussion

Does the color of a surface make a difference in how well it absorbs thermal radiation? If so, how? The answer to these questions could help you decide what to wear on a hot, sunny day and what color to paint your house if you live in a hot, sunny climate. In this experiment, we will compare the thermal absorption ability of three surfaces: silver, black, and white. We'll do this by filling cans with these surfaces with water, then exposing the cans to heat lamps. We'll measure the temperature of the water in each of the cans while they're being exposed to the heat and see if there's a difference in the rate at which the temperatures increase.

Procedure

1. In which of the three cans do you think the water will heat up at the fastest rate?

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2. In which of the three cans do you think the water will heat up at the slowest rate?

Step 1: Arrange the apparatus so that the heat lamp will shine equally on all three cans. The cans should be about one foot in front of the lamp. Do not turn the light on yet.

Step 2: Fill the cans with cold water and wipe up any spills. Quickly measure the initial temperature of the water in each of the cans and record it in Table A.

Step 3: Turn on the lamp and start timing. Place the thermometer in the silver can.

Step 4: At the 1-minute mark (1:00), read the temperature of the water in the silver can and record it in Table A. Quickly move the thermometer to the black can. Gently swirl the water in the can with the thermometer.

Step 5: At the 2-minute mark (2:00), read the temperature of the water in the black can and record it in Table A. Quickly move the thermometer to the white can. Gently swirl the water in the can with the thermometer.

Step 6: At the 3-minute mark (3:00), read the temperature of the water in the white can and record it in Table A. Quickly move the thermometer to the silver can. Gently swirl the water in the can with the thermometer.

Step 7: Repeat steps 4–6 until the 21-minute mark temperature reading is made.

Table A

Silver Can Temperatures (°C)	Black Can Temperatures (°C)	White Can Temperatures (°C)
Initial	Initial	Initial
T at 1:00	T at 2:00	T at 3:00
T at 4:00	T at 5:00	T at 6:00
T at 7:00	T at 8:00	T at 9:00
T at 10:00	T at 11:00	T at 12:00
T at 13:00	T at 14:00	T at 15:00
T at 16:00	T at 17:00	T at 18:00
T at 19:00	T at 20:00	T at 21:00

Step 8: Turn off the heat lamp.

3. Plot your data for all three cans on a single temperature vs. time graph.

Step 9: Determine the change in temperature for the water in each can while the heat lamp was on.

4. Determine the temperature change in the silver can while the heat lamp was on. Subtract the 1-minute mark temperature reading from the 19-minute mark temperature reading.

   Temperature change in silver can: _____°C

5. Determine the temperature change in the black can while the heat lamp was on. Subtract the 2-minute mark temperature reading from the 20-minute mark temperature reading.

   Temperature change in black can: _____°C

6. Determine the temperature change in the white can while the heat lamp was on. Subtract the 3-minute mark temperature reading from the 21-minute mark temperature reading.

   Temperature change in white can: _____°C

Summing Up

1. In which can did the water heat up at the fastest rate? In which can did the water heat up at the slowest rate? Did your observations match your predictions?

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2. Which would be a better choice if you were going to spend a long time outdoors on a hot, sunny day: a black T-shirt or a white T-shirt?

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3. What happens to the thermal radiation that falls on each of the cans: is it absorbed or reflected?

   Silver:_____ Black:_____ White:_____