

Name: _____

Date: _____

Investigating Light's Effect on Warming Up Water

Investigation Questions

In this investigation, we will be answering 2 questions:

1. Does light affect the temperature of the water inside the cup system?
2. How does the cup surface affect how light warms up the water inside the cup?

Predictions

In which cup do you think water would warm up the most? The least?

Materials

Group A's and Group B's: 1 lamp with 100-W light bulbs, 1 copy of *Light Measurement Template*, 2 thermometers, 1 500-mL beaker, timer (optional), 800 mL of chilled water

- Group A: clear plastic cup and foil-wrapped cup (both with lids)
- Group B: white-painted cup and black-painted cup (both with lids)

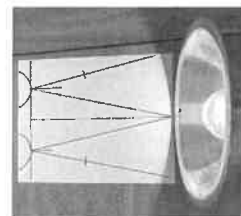
Dark Group(s): 4 thermometers, 1 500-mL beaker, timer (optional), 1600 mL of chilled water, clear plastic cup, foil-wrapped cup, white-painted cup, and black-painted cup (all with lids)

Water Temperature Procedures

Group A's and Group B's Arrange the lamp so that it is standing as vertically as possible (perpendicular to the table) and shining directly at the cups.



Place 1 the *Light Measurement Template* in front of the lamp so that the lamp's edge is flush with the template's edge and the center line is aligned with the light bulb.

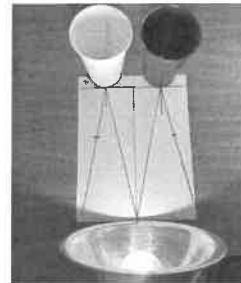


All Groups

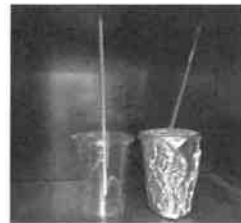
Place a thermometer through the straw hole in each lid. Place the lids and thermometers to the side of your cups until you are ready to close the cups.



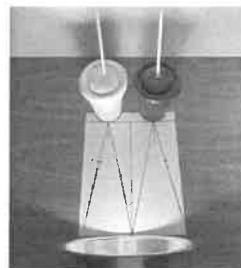
Groups A and B, place the cups on the other end of your template. Then fill the beaker with 400 mL of cold water and pour it into the first cup. Repeat for the second cup.



Dark group, place your cups on a flat surface in a completely dark space. Then fill the beaker with 400 mL of cold water and pour it into the first cup. Repeat for the second cup.



Seal the cups with the lids, positioning the thermometer in each cup at a level where it will take a temperature measurement from the middle of the water and where you can read it easily.



Wait 20 seconds and record your starting temperature measurement. You will measure the water temperature after 15 minutes. While you wait, go to the Scientists Circle to collect light measurements with your class.

After 15 minutes, return to your cups to record the final temperature measurement. Calculate the change in water temperature for each cup type and record it on the class data table.

Water Temperature Data

Water Temperature over Time (°C)

Starting water temperature: _____

Air temperature around the cups: _____

Group A - Light		
Condition	15 min	ΔT
Clear		
Foil		

Average (clear): _____

Average (foil): _____

Group B - Light		
Condition	15 min	ΔT
Black		
White		

Average (black): _____

Average (white): _____

Dark Group		
Condition	15 min	ΔT
Clear		
Foil		
Black		
White		

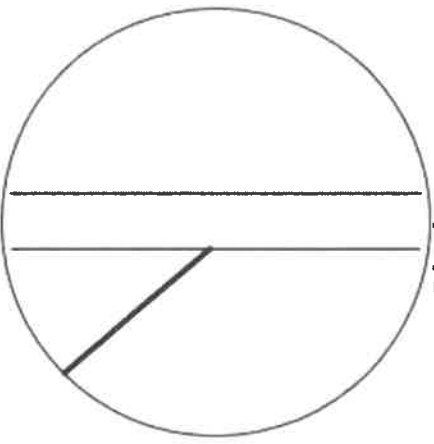
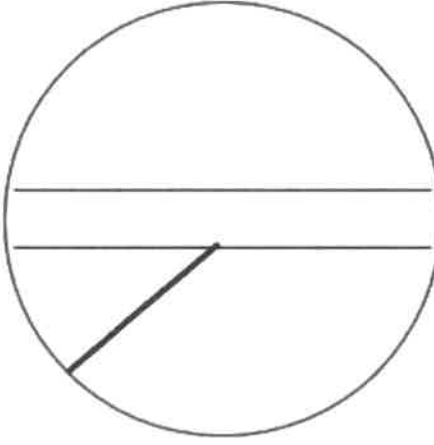
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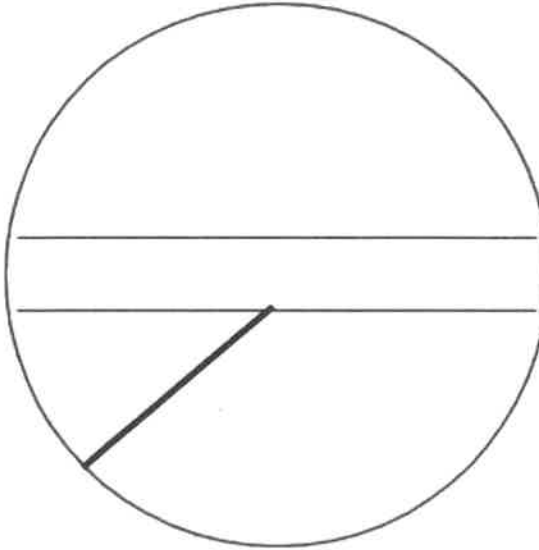
Explaining Temperature Changes in Each Cup

Use drawings and words to explain how each cup surface affected how light warmed up the water differently.



<p>Clear plastic cup (light)</p>	<p>Clear plastic cup (dark)</p>
<p>How did you explain why the clear plastic cup in the dark was different from the other cups?</p>	

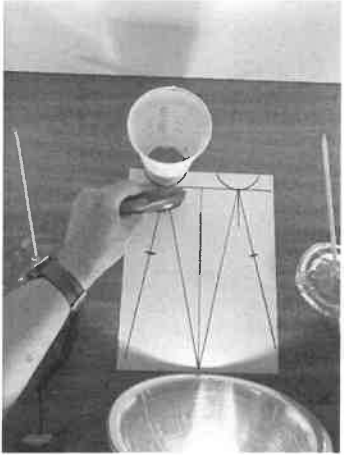
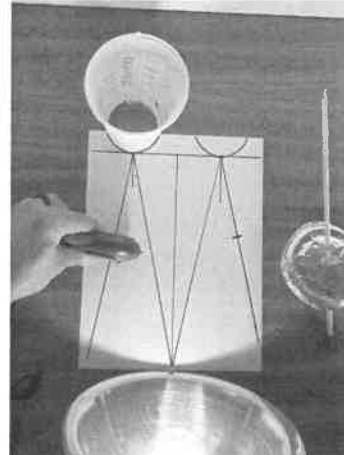
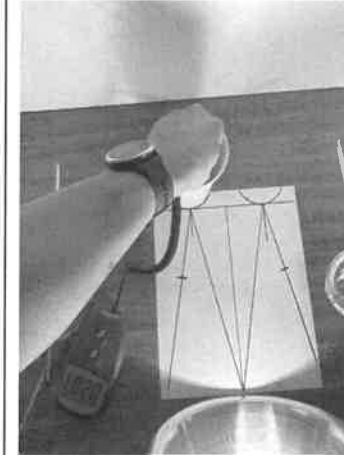
 <p>Black cup</p>	 <p>White cup</p>
<p>How did you explain how the water in the black-painted cup warmed up compared to the water in the white-painted cup?</p>	

 <p data-bbox="836 987 876 1113">Foil cup</p>	<p data-bbox="893 504 933 1816">How did you explain how the water in the foil-covered cup warmed up differently compared to the other cups?</p>
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What questions do you have about what happened in the cups?

Light Measurements Procedures

1. Place 1 cup in the upper left corner of the *Light Measurement Template*.
2. Measure the amounts of incoming, reflected, and transmitted light 2-3 times and calculate the average.
 - a. When taking incoming and reflected light measurements, the light meter should be held horizontally with the center of the light sensor aligned with the template's center line.

		
<p>Incoming light should be measured by aligning the sensor over the center line with the back of the sensor hitting the cup.</p>	<p>Reflected light should be measured by aligning the sensor with the center line, facing the cup and behind the dash.</p>	<p>Transmitted light should be measured by placing the sensor vertically inside the cup so that it hits the bottom and is close to the cup wall.</p>

Light Measurements Data (lux)

Light Measurements (lux)

Condition	Incoming	Transmitted	Reflected
Clear			
Foil			
Black			
White			

Light Measurements (percentages of incoming light)

3. Calculate the percentages of incoming light that transmit through and reflect off the cup wall.

$$\% \text{ Transmitted light} = \frac{\text{Amount of transmitted light (lux)}}{\text{Amount of incoming light (lux)}}$$

$$\% \text{ Reflected light} = \frac{\text{Amount of reflected light (lux)}}{\text{Amount of incoming light (lux)}}$$

Condition	Transmitted	Reflected
Clear		
Foil		
Black		
White		

Analysis

1. Combine the average temperatures and the percentages of incoming light in the table below.

Average Water Temperature Change vs. Light Measurements (% Incoming Light)

	Condition	ΔT	Transmitted	Reflected
Light	Clear			
	Foil			
	White			
	Black			
Dark	Clear		0	0
	Foil		0	0
	White		0	0
	Black		0	0

2. What do you notice and wonder about how light changes (or does not change) the water temperature in each cup type?

Notice	Wonder