Graphical Analysis **23**

Reflection and Absorption of Light

Would you feel cooler wearing a light- or dark-colored shirt on a hot, sunny day? The color and texture of an object influences how much radiant energy from the sun the object will absorb or reflect. Every color reflects a certain amount of light while absorbing the rest as heat energy. The amount of reflected light is called the color's *light reflectance value*. Dark colors with low light reflectance values tend to reflect little light while absorbing lots of heat energy, whereas light colors with high reflectance values reflect a lot of light and absorb little energy. People in warm, sunny climates are more likely to purchase light-colored cars since they don't heat up as quickly as dark-colored ones. Many house paints come with a predetermined light reflectance value to guide consumers when making color choices for their homes. Since Earth's surface is made of many colors and textures, it is heated unevenly. Snow, ice, and clouds reflect a lot of energy back into space, while green forests and vegetated lands absorb energy.

In this experiment, you will investigate the relationship between the percent reflectivity of various colors and the temperature change due to energy absorption. You will measure the amount of light reflected from paper of various colors using a light sensor and calculate percent reflectivity. You will also use a temperature probe to measure the temperature change of the air under the paper due to energy absorption by the paper.

OBJECTIVES

- Use a light sensor to measure the amount of reflected light.
- Calculate percent reflectivity of various colored paper.
- Use a temperature probe to estimate the amount of energy absorbed by the paper.

MATERIALS

Chromebook, computer, **or** mobile device Graphical Analysis app Go Direct Light and Color Go Direct Temperature lamp with 100 W equivalent bulb aluminum foil white paper black paper 2 other pieces of colored paper ring stand utility clamp tape ruler

PROCEDURE

- 1. Launch Graphical Analysis. Connect the Go Direct Light and Color Sensor and the Go Direct Temperature Probe to your Chromebook, computer, or mobile device.
- 2. Set up the data-collection mode.
 - a. Click or tap Mode to open Data Collection Settings.
 - b. Change Rate to 0.1 samples/s and End Collection to 600 s.
 - c. Click or tap Done.
- 3. Prepare the sensors for data collection.
 - a. Secure the temperature probe to the table by placing a piece of tape across the handle. The tip of the probe should not be touching the tabletop.
 - b. Place the piece of white paper over the temperature probe.
 - c. Use a utility clamp and ring stand to fasten the Go Direct Light and Color Sensor 5 cm above the table top as shown in Figure 1. The sensors should be facing down toward the table.
 - d. Position the lamp so that the bulb is 10 cm above the table top and next to the Light and Color Sensor.
 - e. The classroom lights should be on.





- 4. Switch on the light bulb and click or tap Collect to start data collection.
- 5. When data collection is complete, determine and record the mean light reflection value and the minimum and maximum temperature readings.
 - a. Turn off the light bulb when data collection is complete.

 - c. Record the mean light reflection value in your data table (to the nearest whole lux).

 - e. Record the minimum and maximum temperature readings (round to the nearest 0.1°C).
- 6. Repeat Steps 4–5 for black paper and aluminum foil. If time allows, make and record readings for two additional colors of paper.

DATA

Color	White paper	Black paper	Aluminum	
Starting temperature (°C)				
Final temperature (°C)				
Change in temperature (°C)				
Reflection value (lux)				
Percent reflectivity (%)			100	

PROCESSING THE DATA

- 1. Subtract to find the change in temperature for each color paper.
- 2. Which color paper had the largest temperature increase?
- 3. Which color paper had the smallest temperature increase?
- 4. Solar collectors can be used to absorb the sun's radiation and change it to heat. What color would work best for solar collectors? Explain.
- 5. Calculate the percent reflectivity of each color paper using the following relationship:

$$\%$$
 reflectivity = $\frac{\text{reflection value for paper}}{\text{reflection value for aluminum}} \times 100$

Show your work in the data table above.

- 6. Which color paper has the highest reflectivity?
- 7. Which color paper has the lowest reflectivity?
- 8. What relationship do you see between percent reflectivity and temperature change?
- 9. What types of surfaces might give a planet a high reflectivity? Explain.
- 10. Does the planet Earth have high reflectivity? Why or why not?

EXTENSIONS

1. Design an experiment to test the reflectivity of sand, soil, water, and other materials. Perform the experiment you designed.

2. Design an experiment to test the effect of texture on reflectivity. Perform the experiment you designed.