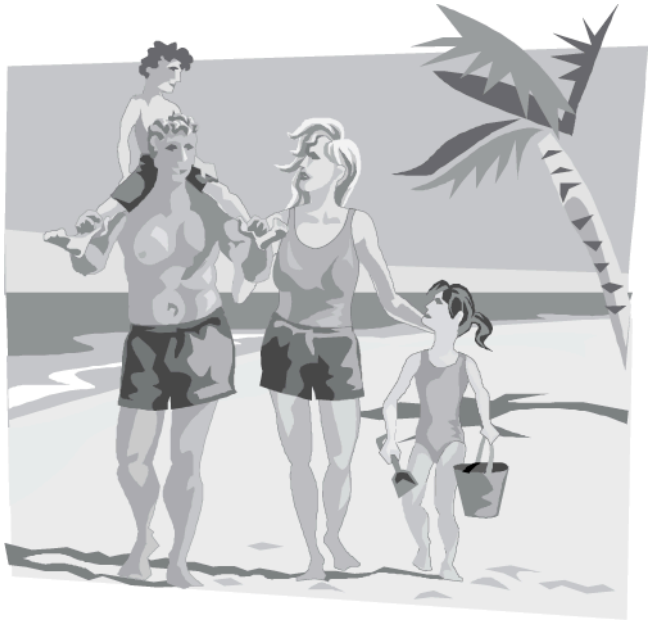
Chapter 3. Surface Color and Effect on Temperature Change: A Confirmation-Verification Activity

Think About This!

On a hot summer day, do you find dark or light clothing the most comfortable to wear in the bright sunshine? Explain. Have you ever walked barefoot across a dark pavement or sandy beach during a bright, hot summer day? What was the experience like? On a bright, hot summer day, if you had to walk barefoot down a dark sidewalk or along pavement lined with green grass, which surface would feel most comfortable to your feet? Why?



Probing Further

You will investigate an important factor (color) that can cause differences in Earth's surface temperature. However, as you work through the series of activities in this publication, you might discover complicating factors that can influence a simple explanation. What do you think some of these factors might be? Do you think sunlight falling on a green grass surface raises the temperature to the same degree as that falling on a dark surface? Explain.

This activity should confirm that a dark surface absorbs more energy than a light surface, as is indicated by differences in the final readings of two thermometers.

Objectives for the Learner (Essentials of Inquiry)

Conceptual Theme: To develop a basic understanding of relative change in temperature relating to the surface color of an object.

Content: Develop a basic understanding that the heating (indicated by temperature differences) of an object is related to the degree of an object's surface color.

Skills: The focus is on handling laboratory equipment, making careful observations, recording temperature differences, reaching conclusions, and describing and communicating results.

Scientific Habits of Mind: The importance of careful observations, respect for data, verifying results and performing experiments safely.

Materials

2 large containers

2 foam caps

2 non-mercury thermometers

1 sheet of dark construction paper

1 sheet of light construction paper

Transparent tape

Scissors

Heat lamp (or lamp on stand equipped with 100-watt bulb)

Safety glasses

Preparation

Place the two containers on a level surface and allow the air inside the containers to equalize with air in the room. This should take no more than about 10 minutes.

While waiting for the temperatures to equalize, you can complete the following steps.

Cut a strip of dark paper to fit one container and tape this paper around the outside of the container covering its surface.

Cut a strip of light paper to fit the other container and tape this paper around the outside of the container covering its surface.

Cut two pieces of foam to firmly fit like caps inside the top of each of the containers**.** **NOTE: Manufactured plastic drink caps are too flimsy.**

Cut slots in each of the foam caps for inserting the thermometers (this should be a snug fit). Insert one thermometer inside the slot of each of the foam caps.

Place the caps with the thermometers inserted firmly on each container, making sure that the liquid in the thermometer is visible. Record the temperature of each thermometer.

Put the two containers side by side and place the heat lamp about 6 inches from the containers. Plug the light into an electrical outlet and turn it on.

Record the temperature of both thermometers at 5-minute intervals, 5 different times.

Your completed setup for conducting the experiment should look like Figure 3-1.

Examining Results

Did the temperature rise in both containers? Explain.

It is expected that there was a temperature rise in both the containers, but it is likely that the dark-colored container reached a higher temperature than the light-colored container. Make certain that the students use the results of the data collected from the activity, even if it does not support the expected results.

Did the temperatures in each of the containers rise at the same rate? Explain.

It is expected that the temperature rose at a faster rate in the dark-colored container. Make certain that the students use the results of the data collected from the activity.

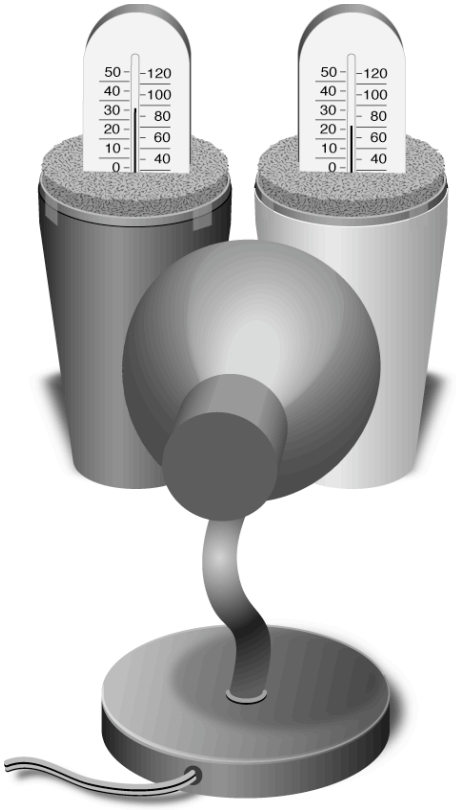


Figure 3-1. Experiment setup.

What was the final temperature at the end of 25 minutes in each of the containers?

Students should record the temperatures of each container at the end of the 5-minute intervals and at end of the activity. It is expected that there was a temperature rise in both the containers, but it is likely that the dark-colored container reached a higher temperature than the light-colored container. Make certain that the students use the results of the data collected from the activity.

How did you present the results? Explain.

Appropriate ways to present the results are both table and graph form. Time should be placed on one axis and temperature on the other axis to view both the rate of rise and the final resulting temperatures.

Conclusion

Which of your conclusions did the resulting data support?

While it is essential that the collected data determine the conclusion, it is expected that the main conclusion supported by the data will be that the dark-colored container's temperature rose more rapidly and reached a higher final temperature. Deviations from this result need to be explored and discussed with the students.

Going Further

What are some various ways to present your observations?

Both charts and graphs are appropriate ways of presenting data.

How could you vary this activity and learn more about surface color and temperature rise?

There are a number of comparisons that could be made regarding temperature change; some examples are:

a. *Repeat the activity several times.*

b. *Conduct the activity comparing other colors.*

c. *Add materials such as sand to the container and check for temperature changes.*

d. *Fill like-colored containers with different materials, such as sand and water, and examine the results.*

Challenge

Try designing an activity to verify that materials of the same surface color but varying composition affect the absorption of energy.

Background for the Teacher

This confirmation-verification activity should simply show that light and dark surfaces (made of the same material) show a difference in increase of temperature over a 25-minute period, with the dark-colored container reaching the highest temperature reading. Dark surfaces become warmer because they absorb more of the incident radiation. Light-colored surfaces reflect more of the incident radiation, hence absorbing less radiation. The higher the absorption, the warmer the temperature.

This concept is very important for students, who will eventually better understand that temperature differences, as influenced by the different surface colors of the Earth, result in important changes in the movement of air. It is an extremely important "building block" to this eventual understanding and application to other situations. As an example, place two pieces of construction paper, one white and one black, on top of snow or boxes filled with ice. Aim a heat source of equal intensity and distance at both the white and black pieces of construction paper. Observe the results.

The data will likely show that the dark surface reached a higher temperature and at a faster rate. This result should form the basis of the learner's conclusion. Graphing the information is a good way to determine the rate of rise in both containers. You should ensure that the generated data support the conclusion and thus reinforce an important scientific habit—"respect for data."

Both "Going Further" and "Challenge" can be addressed by having the learner compare the temperature increases in containers with various characteristics and contents. Encourage the students to be innovative in their designs.