Absorbing Light: Dark Versus Bright

Overview

Students will use black and white construction paper and a light source to learn that dark objects absorb more light and reflect less light than bright objects. The activity also demonstrates the conversion of radiant light energy into heat energy.

Concepts

- Dark surfaces absorb more visible light energy than bright surfaces
- Dark surfaces reflect less visible light energy than bright surfaces
- Energy can change forms, in this case from radiant light energy to heat
- Clouds, being bright, reflect significant amounts of sunlight and help to regulate Earth's temperature

Materials

- 2 thermometers
- Flood lamp, desk lamp, or area in direct sunlight
- Ruler
- Construction paper, 1 piece white, 1 piece black, or 2 sheets photocopy paper
- Scissors
- Cellophane tape or rubber bands
- 2 empty metal food cans, same size (be sure rims are not jagged)

Preparation

The paper and the cans can be prepared beforehand or prepared as part of the activity (see Procedure). Although two cans with their tops completely removed can be used, the experiment will be more effective (have fewer external effects), if only holes are placed in the cans' lids, e.g., two holes from a bottle opener to empty material out of the can, and one center hole created with an awl for the thermometer. Only one hole is actually needed for the experiment - for the thermometer. Cans can optionally be filled with water, or this can be done as a separate experiment to demonstrate the higher heat capacity of water compared to air.

You can either use a flood lamp or a desk lamp (light bulb) to simulate sunlight, as described here, or you can place the cans on a windowsill (window closed) or other sheltered area in direct sunlight. A flood lamp will be the most effective option, causing the largest temperature increases.

Procedure

Engagement

Discuss whether dark surfaces (e.g., asphalt) or bright surfaces (e.g., concrete) tend to get hotter in sunlight. Which would you rather walk on during the day in the summertime? What color are solar cells, for example those found on some calculators or freeway call boxes?

Activity

1. Cut a piece of white construction paper to fit around the outside of one of the cans in the same way that a can's label would. Do the same with the black construction paper and the other can. Alternatively, you can use white photocopy paper and create the black piece by heavily overexposing one of the pieces.
2. Secure one piece of paper to each can with tape or rubber bands.
3. Place one thermometer inside each can.
4. Read and record the temperature on both thermometers in Table 1.
5. Position both cans about 12 in. (30 cm) from the lamp.
6. Turn lamp on.
7. Read and record temperature on both thermometers after 10 minutes.
8. Compare the temperatures just recorded for the two cans.

Table 1: Temperature Data

Can	Starting Temperature	Temperature after 10 minutes
White		
Black		

Explanation

Light from the lamp is absorbed by the cans just as light from the Sun is absorbed by objects. When the light is absorbed it is transformed into heat energy. The more light that is absorbed, the more heat is produced. Dark objects absorb more light. Another way to think of this is bright objects reflect more light. So, dark objects under the same conditions get hotter than bright objects, just as dark surfaces, or dark portions of surfaces get hotter than bright areas under the same conditions. A typical black object may absorb 90% of visible light. A mirror reflects over 90% of incoming visible light. Clouds, ice, and snow are very bright and therefore reflect most of the sunlight that hits them. All have the effect of keeping average temperatures on Earth cooler than they would be otherwise.

Extension

The *albedo* of an object is a quantitative way to measure its brightness and is often used to describe the brightness of a planetary surface. Higher albedo surfaces (bright) reflect more light and absorb less than low albedo (dark) surfaces. Earth, on average, has an albedo of approximately 0.39, partly due to bright clouds. In other words, on average the Earth reflects 39% of the incoming sunlight, thus keeping temperatures cooler. The Moon has an average albedo that is much lower, about 0.08, meaning that it reflects only about 8% of incoming sunlight. The Moon is thus very dark and appears bright at night primarily due to the contrast with the blackness of space.

Links to Related CD Activities, Images, and Movies

Activity *Solar Energy and Distance*

VOCABULARY

albedo

SOURCE

Modified from *Astronomy for Every Kid* by Janice VanCleave, New York: Wiley and Sons, pg. 6-7, 1991.