Activity 1: Absorbing Heat from the Sun

Time Required: 20 minutes

Materials List

Group Size: Entire Class

To share with the entire class:

- Infrared thermometer
- Black pan
- Silvered pan
- Oven gloves

Youth Worksheets:

- None

Learning Objectives

After this activity, students should be able to:

- Identify heat transfer by radiation.
- Explain that a black surface absorbs more solar radiation than a white surface.
- Explain that a white surface reflects more solar radiation than a black surface.

Introduction:

During this module you will be designing and building a solar oven. In the first activity, we will be looking at specific ways in which objects are heated up by the sun and determining what factors affect the amount of heat absorbed or reflected by the objects. We want to collect as much heat as possible in our solar ovens.

You may not know it, but you probably have experienced how a solar oven works. What happens when a car sits in the sun on a hot summer day? [Let the students think about this for a minute. Answer: It gets hot.] Can it get hotter than the outside air temperature? [Answer: Yes, because sometimes it's hard to get in the car at first.] The car is acting kind of like the solar ovens we are going to build.

The sun's rays enter the windows strike the interior of the car. Heat from the sun's rays is called solar radiation and is a form of energy. Depending on the color of the interior, some solar radiation will be absorbed and some will be reflected. The absorbed radiative energy is converted to heat in that material. This is called heat transfer through radiation. We have already set up a short experiment outside to test this.

[At this time, take the students outside to view the experiment.]

Vocabulary

Word	Definition
Radiation	Energy transferred through the movement of electromagnetic waves; heat transfer not requiring a medium.
Solar Radiation	The amount of power received on the Earth's Surface per unit area (Watts per square meter in the SI unit system)

Procedure

Before the Activity: 20 Minutes
On the day before the activity, spray paint one of the two pans black if it has not already been done for you by a previous class.

On the day of the activity, place the two pans outside in the sun a few hours before class. This exercise will work when there are some clouds but will work better on a sunny day.

During the Activity:

Once outside, show the students the two pans. Then, ask the students, “Which pan do you think will be hotter?” [Let students provide a few ideas as to why one will absorb more than the other. Then, take a vote.]

Explain to the students, “The hotter pan is the one that has absorbed more solar radiation. It is difficult to measure the temperature of a surface using a thermometer. If you hold it directly against the surface, the side of the thermometer against the surface will be at the surface temperature while the other side will be at the air temperature. The measurement will be somewhere in between. Instead, we will be using an infrared thermometer that measures the temperature of the surface by measuring the heat being given off by the surface in the form of radiation.”

Demonstrate for the students how to use the infrared thermometer. Position the infrared thermometer a few inches away from the surface of the pan you want to measure and point the infrared thermometer at the pan. The infrared thermometer will provide the temperature of the surface. The controls on the thermometers may vary.

Ask two student representatives to measure the temperature of each pan. The class should measure a significantly higher average temperature on the blackened pan than on the silvered pan.

Processing and Activity Closure:
After the measurements have been made, you can ask the class, “Which pan was hotter, the black or the white one? Was this what you expected?” [Answer: The black pan should have been hotter.]

Next, you can explain to the students, “When you see an object, you usually identify it by the color that it reflects back to your eyes. The reason the object appears as that color is that all other colors are absorbed. When you see white, you actually see a combination of all colors. Black is the absence of color. So when you see a white object, it actually reflects most of the light shining on it. A black object absorbs most of the light shining on it. That is why the black pan was hotter.”

They may already have answered the following question on their own, but if it has not come up yet, ask the students, “When you go outside on a hot day, would you feel cooler if you were wearing a white shirt or a black shirt assuming both were made of the same material?” [Answer: A black shirt tends to be hotter.] A black shirt tends to be hotter. In general, a black object absorbs more heat through radiation than the same object would if it were white.

Finally ask the students, “If we want to collect as much heat as possible from the sun in our solar ovens, what color should the inside of the solar oven be painted?” [Answer: At least some of it should be painted black.] As we discuss the solar oven further, we will discuss which parts of it are most useful to paint black.

During the next activity which is also outside, allow the students who did not use the infrared thermometer during this demonstration to come over and make the measurements themselves if they would like to.

Embedded Assessment
None

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