Can the Sun be used to heat water?

Overview: Although you won't need any lab coats, we are getting serious with our scientific skills here. We're going to explore the sun's energy potential in our experiment today.

What to Learn: You'll explore how the sun affects what we see as energy every day.

Materials

- Paint brush
- Thermometer (outdoor type)
- Newspaper
- Aluminum foil
- Water
- Large plastic glass
- Empty aluminum 12-ounce (355 milliliter) soft drink can
- Black paint or spray paint (flat, not shiny)

Lab Time

1. Go outside and spread a sheet of newspaper on the ground. Place an empty aluminum soft drink can on the newspaper. Have an adult help you paint the outside of the aluminum can. You can use a brush and can of paint or spray paint. Be sure to use paint that is suitable for a metal surface. The paint should give you a flat (not shiny) surface. Be sure not to get the paint on anything but the can and newspaper. After painting, set the can where the paint can dry overnight.
2. You will need to do the rest of this experiment on a warm, sunny day. Partially fill a large plastic glass with cool tap water. Check the temperature of the water with a thermometer. Pour the water from the plastic glass into the painted black can, completely filling the can. Pour out any extra water remaining in the plastic glass. Cover the can's opening with a small piece of aluminum foil about the size of a quarter.
3. Set the black can outside in a sunny spot. Pick a place where the sun will shine on the can all day. (You do not want the can to be in the shade.)
4. After the can of water has been in the sunshine for about four hours, pour the water into the large, plastic glass. Check the temperature of the water with the thermometer. Feel the outside of the can.
5. Record your observations on the worksheet below, and continue to discuss what's going on in this experiment.

Heating Water Data Table

Time	Temperature
Beginning of experiment	
After 2 hours	
After 4 hours	

Total difference in temperature: (+/-)

Reading

When the sun is overhead, about 1,000 watts of solar power strike 1 square meter (10.8 square feet) of the earth's surface. Using solar cells, this solar energy can be converted to electricity. However, because sunlight cannot be converted completely to electricity, it takes at least a square meter of area to gather enough sunlight to run a 100-watt light bulb.

Solar energy is still more expensive than other methods of generating electricity. However, the cost of solar electricity has greatly decreased since the first solar cells were developed in 1954.

It has been proposed that panels of solar cells on satellites in orbit above the earth could convert solar energy to electricity twenty-four hours a day. These huge solar power satellites could convert electrical energy to microwaves and then beam these microwaves to Earth. At the earth's surface, tremendous fields covered with antennas could convert the microwave energy back to electricity.

It would take thousands of astronauts many years to build such a complicated system. However, there are many practical uses of solar energy in use today. These uses include heating water, heating and cooling buildings, producing electricity from solar cells, and using rain and snow from the water cycle to power electrical generators at dams.

In this experiment, you should find a significant increase in the temperature of the water that was left in the black can during the day. The tap water initially may be about 21°C (70°F), but after the water has been heated inside the can, the temperature should rise to more than 38°C (100°F). The exact temperature you achieve in your miniature, solar water heater (black can) will depend on your location and the time of year. However, you should find that the water temperature will go much higher than the temperature of the outside air.

The energy of sunlight powers our biosphere (air, water, land, and life on the earth's surface). About 50 percent of the solar energy striking the earth is converted to heat that warms our planet and drives the winds. About 30

percent of the solar energy is reflected directly back into space. The water cycle (evaporation of water followed by rain or snow) is powered by about 20 percent of the solar energy.

Some of the sunlight that reaches the earth is used by plants in photosynthesis. Plants containing chlorophyll use photosynthesis to change sunlight to energy. Since these green plants form the base of the food chain, all plants and animals depend on solar energy for their survival.

The electromagnetic radiation from the sun includes ultraviolet, visible, and infrared radiation. Ultraviolet radiation is the type of sunlight that causes tanning of skin. Visible radiation is the type of sunlight we see with our eyes. Infrared radiation is the type of sunlight that we feel as heat when the sun is shining on our skin. All these forms of solar radiation have energy associated with them.

When solar energy from the sun's electromagnetic radiation strikes a black surface, solar energy is converted to heat energy and the surface is warmed. Other colors will absorb solar energy, but lightly colored surfaces tend to reflect the light, while darker colors absorb the solar energy. You may have noticed this difference if you ever walked barefoot on a dark road on a hot summer day.

Direct solar energy is not hot enough for cooking. The higher temperatures required for cooking or for changing water to steam require concentrating the energy of sunlight with mirrors or lenses. However, directly absorbed solar energy is hot enough for heating homes and producing hot water with little or no energy costs.

When we turn on a hot water faucet at a sink, water is taken from a hot water tank. In industrialized countries, we usually heat water using electricity or natural gas and store the hot water in this insulated tank. However, around the world, there are millions of solar heaters used for heating water.

Solar water heaters use a black metal plate covered with insulated glass. These solar heaters are usually placed on rooftops to receive the maximum amount of sunlight. Water flows through tubes beneath the black metal plates. Solar energy heats the black metal plates and the water passing in tubes underneath the plates. The heated water is piped to a storage tank, where it is kept until needed. If the location of the solar heater is not consistently sunny, then an auxiliary heater--using electricity or natural gas--is sometimes used to heat the water.

Exercises Answer the questions below:

1. The solar energy that hits the earth is responsible for what proportion of the energy on our planet?
    a. Nearly all of it
    b. About 50%
    c. 25%
    d. None of these
2. Name one way that the physical earth uses the earth's energy:

3. True or false: Solar power is generally less expensive than other forms of power.
    a. True
    b. False

Answers to Exercises: Can the Sun Be Used to Heat Water?

1. The solar energy that hits the earth is responsible for what proportion of the energy on our planet? (Nearly 100%)
2. Name one way that the physical earth uses the earth's energy: (Photosynthesis, the water cycle)
3. True or false: Solar power is generally less expensive than other forms of power. (false)