Build a Solar Water Heater Activity

Note: This activity needs a sunny day with little or no cloud cover.

The Sun is our greatest natural source of heat. Energy from the Sun heats the land, the oceans, and the air. It can also be used to heat water in our buildings. Most water heaters use electricity or they burn natural gas, heating oil, or coal to make the water hot. Unfortunately, it takes a lot of energy to heat water even a few degrees, and therefore heating water is expensive.

But what about the Sun? Yes, the Sun's energy can be used for heating the water in our homes, offices and industrial buildings. Since the 1950s, architects and engineers have been investigating how to do this efficiently and effectively.

Many designs for solar water heaters circulate water through a series of coiled or looped tubes in a collector box with a transparent cover facing the Sun. In this activity, you will find out if such a design really works.

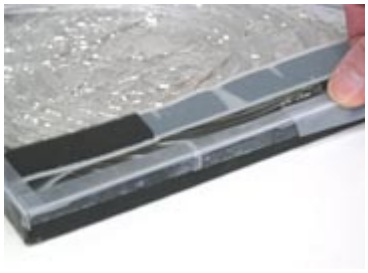
Tools and Materials

- Flat box measuring 21.6 cm x 37.5 cm x 2.5 cm (8.5 in x 14.75 in x 1 in) with two 10-mm (0.4-in) holes punched on opposite ends
- Two 20-cm x 35-cm (8-in x 14-in) sheets of aluminum foil
- One 6-m (20-ft) length of clear plastic tubing measuring 10 mm in outside diameter
- Two 1 m (3 ft) lengths of clear plastic tubing measuring 10 mm in outside diameter
- Two 2.5-cm (1-in) lengths of clear plastic tubing measuring 6 mm (0.25 in) in outside diameter
- One clear rigid acrylic sheet measuring 21.6 cm x 37.5 cm
- One small funnel
- One 400 ml (14 oz) plastic beaker
- Two alcohol bulb thermometers
- Two spring-loaded clothespins
- Masking tape
- One submersible water pump
- One pair of alligator clip leads
- One battery box for four AA batteries
- Four AA batteries
- Water

What to Do

1. First, you need to assemble the solar water heater panel in the flat box. Spread the aluminum foil on the bottom of the box. Place the 10-mm-diameter tubing into the box and insert one end into one of the holes in the side of the box. Coil the remainder of the tubing into a spiral. Then thread about 30 cm of the other end of the tubing out through the hole in the opposite side. Place a small bulb thermometer on top of the coiled tubing so that you can read the temperature inside of the case once it is enclosed.

2. Place the clear rigid acrylic sheet on top of the assembled case. Tape the acrylic sheet to the case to make an enclosed space containing the aluminum foil, coiled tubing, and thermometer. This completes the assembly of the solar water heater panel.



3. Before you put water in the tubing you need to get a starting temperature. Fill the plastic beaker with water and insert a bulb thermometer. Wait a few minutes and then read the temperature of the water. Record this initial water temperature value in the table below.

4. Stand the panel upright on its long edge. Tape the outlet of the funnel to the 10-mm tubing coming out of the top of the panel. Press the tape firmly to make a good seal.

5. Place two spring-loaded clothespins nearby. Slowly pour water from the beaker into the funnel so that the water flows into the tubing.

6. You will see the water go down into the panel and around the loops of tubing. As soon as water begins coming out of the bottom end of the 10-mm tubing, bend the tubing sharply and fasten it with a clothespin to create a seal. With the panel still upright, seal off the top end of the 10-mm tubing with the other clothespin. Now the tubing in the panel is filled with water. There may be a few air bubbles in the tubing but this will not create problems.

Read the thermometer inside the panel and record this initial panel temperature value in the table below.

7. Place the panel outdoors with the transparent top facing the Sun as directly as possible.

Read the thermometer inside the panel at regular intervals and record the values in the panel temperature column of the table. (Note that the grayed cells in the table will not be used.)

Water temperature	Panel time	Panel temperature
Start:		
Finish:	Finish:	Finish:

After at least an hour in the Sun, take your final panel temperature reading and bring your panel indoors.

8. Stand the panel upright as before and place an empty beaker beneath the tubing at the bottom. Place a thermometer in the beaker. Release the two clothespins so that the water begins to drain from the panel into the beaker.

If all of the water does not drain from the tubing, blow gently but firmly through the end of the top tubing to force the remaining water out of the panel and into the beaker. Wrap the end of the tubing in clean tissue paper before inserting it into your mouth.

Stir the water in the beaker gently with the thermometer to distribute the heat evenly. Read the thermometer and record this final water temperature value in the table.

Look at your results and think about what they mean. Did you see the temperature of the increase steadily? Did it reach a terminal value? How close was the final water temperature to the final panel temperature?

Our Results

When we tried this activity, the initial temperature of our water was 30°C (86°F), and the initial panel temperature was 30ºC. During the hour in the Sun, the panel temperature rose steadily, reaching a value of slightly over 60ºC (140°F). The final temperature of the water that we drained from the panel was 56ºC (133°F).

You will probably get temperatures different from these; however, your water should certainly have a higher temperature after spending time in the solar water heater panel.

Extension

If you want to explore how this solar water heater works in varying conditions, try this same experiment at different times of day, as well as on a cloudy day.