



## Heating Water

### Overview

In the state of Arizona using the sun to heat water makes a lot of sense.

Heating water for use in the home is a major contributor to the home energy bill. One way to reduce energy used by the water heater is to turn its thermostat back; settings from 140 down to 120 degrees will save energy and still provide water hot enough for all the various purposes for which it is used. Another way to reduce energy consumption by the home water heater is to use less hot water. Cold or warm water performs satisfactorily for the typical laundry load. One can take shorter showers or shallower baths. Repairing dripping hot water faucets can save a surprising amount of hot water.

Using the sun's energy is another way to reduce the hot water energy bill. The sun's energy is free, so the cost of solar heated water is less than that of conventionally heated water. Home solar water heaters usually consist of a solar collector, pipes through which water circulates from the collector to the water heater, and a highly efficient water heater similar to a conventional one. The collector, often mounted on the roof, is a dark-colored, glass-faced box in which the sun's heat is trapped. This trapped energy heats the water being pumped through the systems pipes, which pass through the collector. The heated water returns to the water heater, where it is perhaps heated further and is stored for use. The entire system is well insulated, so as to avoid losing heat. Solar water heaters can help lower the high cost of heating water.

### Terms

Insulation: material that hinders the flow of heat energy.

Solar collector: any device used to trap the sun's energy and change it into heat energy.

### Arizona State Standards

S04-S4C3 PO1 Describe ways various resources (e.g., air, water, plants, animals, soil) are utilized to meet the needs of a population.

Examples: solar, wind, water, fossil fuels, minerals, etc. (tie to electrical production)

S04-S4C3 PO2 Differentiate renewable resources from nonrenewable resources.

Examples: solar, wind, water, fossil fuels, nuclear, minerals, trees, air

S04-S4C3 PO3 Analyze the effect that limited resources (e.g., natural gas, minerals) may have on an environment.

S04-S4C3 PO4 Describe ways in which resources can be conserved (e.g., by reducing, reusing, recycling, finding substitutes).

S04-S5C3 PO3 Explain the purpose of conductors and insulators in various practical applications.



## Objectives

The student will investigate the properties of an insulator

The student will construct a simple solar water heater applying what they have learned about color and insulation.

## Materials

Vegetable cans

Paint (white, black, and green, red)

Very hot water

Food color

Ice cubes

Thermometers

Construction paper (white, black, green, red, blue)

Stop watch

Quart jars

Cardboard boxes

Newspaper

Glue or rubber cement

Aluminum foil

Razor knife

Clear plastic wrap

Dowel

Duct tape

Tape

1-qt.can

Flat black spray paint

## Procedures

1. Ask the students how they get hot water at their house. Where does it come from? Ask them if there has ever been a time when they did not have hot water. What was it like?
2. Have the students consider the energy used to heat water for home use. Give each student a copy of the “Jones Family Electricity Use”.
3. Have the students examine the graph and discuss with a partner the questions on the sheet.
4. Share with the class the related information from the background information furnished.
5. Have the students investigate the effect color has on heat.
6. Complete the activity on “Which Color hold heat in the longest?”
7. Help the students make graphs and record data as they follow the instructions on the student sheet.
8. Discuss the results with the students.
9. Have the students investigate color and the time required for ice to melt.
10. Have squares of construction paper in the following colors—white, black, green, red, and blue. Place an ice cube on each square of colored paper.
11. Time and how long it takes for each ice cube to melt.
12. Discuss with the students the results of the investigation.
13. Have the students investigate insulation and solar water heating.
14. Divide the students into groups of three or four each. Give each group a copy of the “Insulation really works”, and have the groups complete the activity as instructed.



15. Allow students to create their own definition of insulation based on what they experience. Relate that definition to water heating and storage.
16. Have the students work in groups to build model solar water heaters.
17. Distribute the “How to Make a Solar Water Heater Model” to each group and provide the materials they need.
18. Have them build the model solar water heater models according to the instructions on the sheet.
19. Have the students experiment with different colors or kinds of containers for the water.
20. Ask the students the following questions:
21. What are some ways energy is used in the home? (Heating, water, air conditioning, appliances, and so on.
22. What are some ways to reduce the amount of energy used to heat water? (Turn water heater thermostat down; use less hot water; repair dripping hot water faucets)
23. Have the students complete the following:
  - a. Define solar energy.
  - b. Define insulation.
  - c. Describe how a solar water heater model works.

**Ask the students the following questions:**

How can we use the sun’s energy to heat our homes and water? (*Heat from the sun can be gathered by solar collectors and stored until needed.*)

Which reaches a higher temperature more quickly when placed in direct sunlight—light colored or dark-colored objects? (*dark*)

How does a solar collector work? (*A solar collector is a box-like device with a glass face, or similar material, and a black interior. It traps and absorbs the energy of the sun’s rays. Water piped through the collector is heated and sent to a storage device*)

**Culminating Activity Ideas:**

Have students make posters or a bulletin board of warm and cool fabrics.

Have the students write to the U S. Department of Energy’s Assistant Secretary for Conservation and Renewable Energy for further information on solar energy

Address: 1000 Independence Avenue, SW, Washington, DC 20585

Invite someone to speak to the class about solar energy.

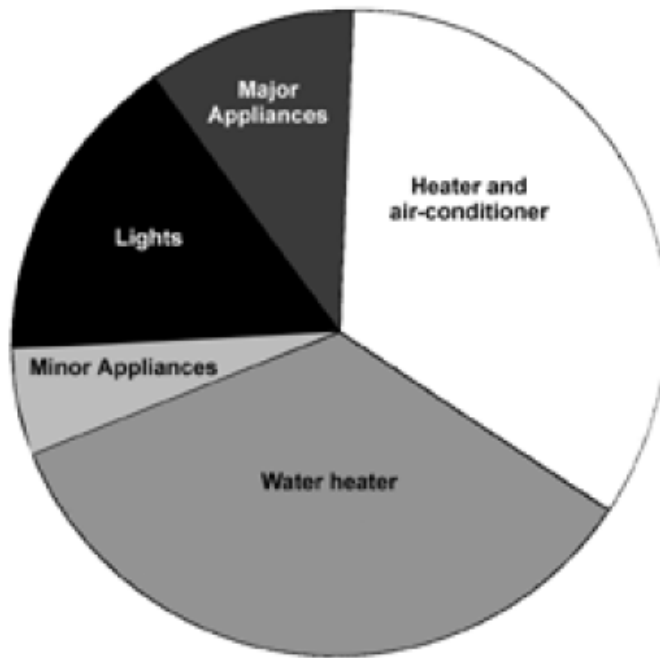


## Jones Family Electricity Use

The Jones family made a circle graph to study electricity usage at their house. The graph shows that a large portion of their bill is for heating water.

1. What are some ways the Jones family could decrease their electric bill?
2. Is there an alternative method for heating water?

Jones Family Electricity Use





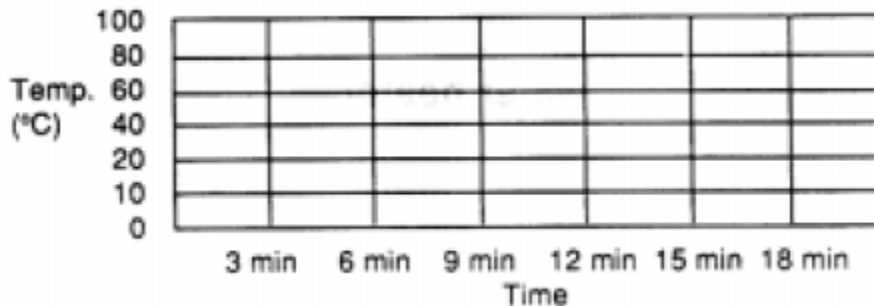
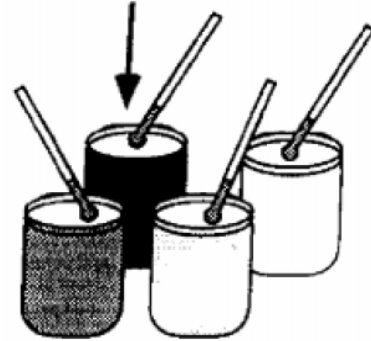
## Which color holds heat the longest?

### Materials:

- 4 juice cans
- 4 colors of paint (white, black, green, and red)
- Very hot water (close to boiling)
- 4 thermometers
- Food colors

### Procedures

1. Paint each can a different color.
2. Fill each can with the same amount of hot water.
3. Add food coloring to the hot water; add drops of all the colors together to get black.
4. Put a thermometer in each can.
5. Read and record the temperature every three minutes until the water cools.
6. Make a graph of the results.



Questions:

Write down your observations.

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Using your data identify the color that held heat best.

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How could you use this information to benefit your life?

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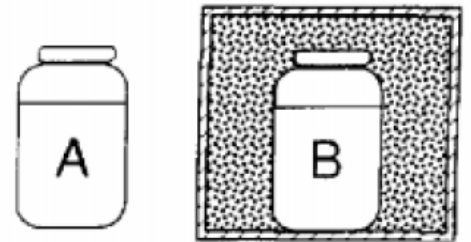
## Insulation Really Works

### Materials

- Two one quart jars
- Hot tap water
- Thermometer
- Cardboard box
- Stop watch
- Newspaper

### Procedures

1. Fill two one-quart jars with hot tap water and put a thermometer in each jar to measure the temperature of the water.
2. Record the starting temperature on the chart below. Next, place one of the jars in a cardboard box. Cover it and surround it with shredded newspapers. The other jar remains as is.
3. After one of the jars is “insulated,” read and record the temperature of each jar every 10 minutes.
4. After 30 minutes have passed, compare the results.
5. Jar A Jar B
6. Starting temperature
7. After 10 minutes
8. After 20 minutes
9. After 30 minutes



	Jar A	Jar B
<b>Starting Temperature</b>		
<b>10 minutes</b>		
<b>20 minutes</b>		
<b>30 minutes</b>		



## How to Make a Solar Hot Water Model

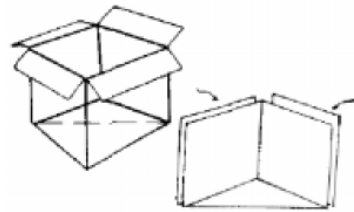
### Materials

Quart jar  
Cardboard boxes  
Newspaper  
Glue or rubber cement  
Aluminum foil  
Razor knife  
Clear plastic wrap  
Dowel  
Silver Duct tape  
Tape  
1-qt.can  
Flat black spray paint

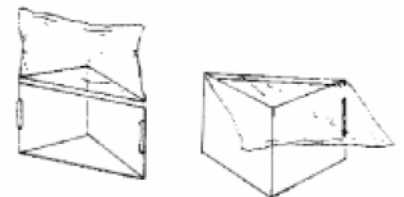
### Procedures

1. Cut a cardboard box in half diagonally. Cut the box in half along the diagonal as shown, leaving a triangularly shaped top and bottom.

Then cut off the top triangle. The leftover piece has two sides that can be cut out to fit flat onto the sides of the remaining box. Then tape them to the sides of the half-box. The side-pieces will add some thickness to the walls and help keep heat inside. Glue aluminum foil to the inside of the box (sides and bottom) with rubber cement (be sure to read the directions on the label).



2. Glazing the box. Tape a small stick of wood (a dowel) across the top corners of the heater box as a brace. Use silver duct tape. Tape clear plastic wrap to the bottom and sides of the box as shown. Make sure it is long enough to have some left over to fold over the top. The fold-overlap can be used as a door to get into the box. You can tape heavy weights to the corners for holding it shut or you can tape the corners down.



3. Prepare the water can. Use any can that is one quart in size and has no leaks. Spray paint it with flat black paint.

4. Set up the water heater.

Open the top of the heater box. Fill the water can, cover the top of it with clear plastic wrap and put a rubber band around the top of the can to seal it.

Place the filled can on the bottom of the heater box and close the top flap. Be sure it is well sealed. Face the front of the box to the south and wait for it to heat up. You can test the temperature of the water by sticking a thermometer into it. You can also experiment with different colors or different kinds of cans and jars.

