A BOX OF SUNSHINE

SUBJECT:
Science

TIME:
150 minutes

MATERIALS:
glass jars with lids, scissors, glue or tape, razor knife, cardboard, thermometers, Styrofoam cups, disposable pie pans, flat black paint, newspaper, measuring cups, plastic wrap, watch, yardstick, paint, brushes, shellac, thumbtacks, scissors, string, duct tape, masking tape, student sheets (included)

OBJECTIVES

The student will do the following:

1. Explain why seasons occur.
2. Define solar energy.
3. Demonstrate how solar energy can be trapped.
4. Construct a simple solar air heater.

BACKGROUND INFORMATION

People have been using the sun's warmth for thousands of years. In ancient civilizations in many places around the world, people learned how to build their homes and other buildings so that they could maximize the sun's warmth in the winter time and minimize it in the summertime. More recently, we have learned to build devices that trap the sun's warmth, making use of "free" energy from the sun—rather than a fuel—to warm water or air. These solar collectors can be built a number of different ways and may serve a variety of purposes. We have also learned more about designing building to take better advantage of solar energy.

Effectively collecting the sun's warmth means that the device or building trapping the solar energy must be positioned so that it receives the maximum amount of energy in the winter—when our Northern Hemisphere is tilted away from the sun, making its warmth less intense. The collector or structure must be faced with a material that lets the sun's rays enter but does not let their warmth escape: glass is the most commonly used material. The collector or structure also usually has a material that helps absorb heat energy. For example, black surfaces absorb heat very well.

Terms

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

solar energy: the energy we get directly from the sun's rays, especially the heat energy we can trap and use.

passive solar system: a device or structure that does not require mechanical parts to collect, store, and make use of solar energy.

PROCEDURE

I. Setting the stage

A. Examine with the students the seasonal variation of the sun's path across the sky.

1. Use a globe and a flashlight to help them understand how the tilt of the earth on its axis causes seasons. In winter, the sun appears lower in the sky because the northern hemisphere is tilted away from the sun. The heat of the sun is spread out more is less intense that it is in the summer. The opposite is true in summer, when the sun appears higher in the sky. The differing tilt of the earth makes the land and seas warmer in the summer and cooler in the winter. Note that calendars are just our way of measuring the time it takes for all these things to happen.

2. Distribute copies of the student sheet "THE SUN'S DAILY PATH," included. Have the students examine the diagram. Discuss it with them, checking their understanding of it.

B. Tell the students that passive solar design principles have been known and used for a long time. This means that for thousands of years, people have known how to construct buildings so that they trap heat when it is needed in the winter but prevent heat gain in the summer. For example, ancient Indians in the American Southwest built homes into the south face of cliffs, so that they would be heated by the winter sun, but sheltered from the summer sun. Some ancient Greek homes had overhanging ledges or roofs for summer shade but winter heat collection. Some of the famous Roman baths were heated by the sun.

1. Have the students do the activity for which the directions follow. (NOTE: Better results will occur during fall and spring months rather than winter months unless the classroom has a south-facing window.)

a. Divide the students into groups of three or four students each. Give each group two thermometers and a glass jar with a lid.

b. Make a chart that looks like the one below on the chalkboard. Have the students copy the chart and record their data on their copies.

Time	Temp. inside jar	Temp. outside jar
0 min.		
5 min.		
10 min.		
15 min.		
20 min.		

c. Each group is to place a thermometer in the glass jar and screw on the lid. Each jar is to be placed in direct sunlight, and a second thermometer placed next to the jar.

d. The students are to read both thermometers and record the beginning temperatures at 0 minutes. They are to read and record the temperatures every 5 minutes for 20 minutes.

2. Have the students draw conclusions about the activity. Ask them the following questions:

a. What happened to the temperature inside the glass jar during the 20-minute period?

b. What happened to the temperature outside the jar during the same time?

c. which temperature was higher after 20 minutes?

d. How did the glass jar affect the heat from the sun?

3. Tell the students that some people use heat from the sun to heat their homes. Ask them to find out about solar collectors. How are they like the jars used in this activity?

II. Activity

A. Have the students investigate collecting solar energy further.

1. Discuss how the angle of the sun's rays is related to temperature. You might have the students repeat the experiment above at different times of the day (e.g. early in the morning, at midday, and at mid-afternoon).

2. Have the students do the activity for which the directions follow

a. Divide the students into groups of three or four and give each group a watch, two thermometers, two Styrofoam cups, and some water.

b. Make a data chart on the board for the students to copy and use. (See I.B, for an example.)

c. The students are to fill both cups with equal amounts of cold water and place a thermometer in each one.

d. They are then to measure the temperature for each cup of water and record it. After putting one cup in the shade and one in the sun, they are to check and record both temperatures after 5, 10, and 15 minutes.

3. Have the students draw conclusions about the activity. Have them answer the following questions:

a. Where is it cooler (sun or shade)?

b. How many degrees cooler is it?

c. What happens to water standing in the sun all day?

d. Would solar energy be a good means of heating a house in the woods?

4. Explain that the sun's energy can be captured most effectively by solar collectors placed on the south side of a house or other building, because the south side receives the most direct sunlight. Of course, it is very important that there is no shade to block the sun's rays.

B. Have the students build and test simple solar collectors.

1. Share the following information on solar heating: Huge amounts of energy come from the sun. We can make use of this energy by changing it into heat for our homes. Some houses have boxes on their roofs. These boxes, called solar collectors, have glass tops and are black inside. Water flows through them and is heated during the day by the sun's rays. When it is warmed, the water then flows to an insulated tank where it is stored for later use.

2. Have the students do the activity for which the directions follow

   a. Divide the students into groups of three or four each. Give each group both two disposable pie pans, flat black paint (not water soluble), a thermometer, a measuring cup, some clear plastic wrap, tape, two Styrofoam cups, and a small stack of newspapers. (NOTE: To save time, you may want to spray paint the pans flat black beforehand.)

   b. Make a chart on the chalkboard like the one below. The students are to copy it and record their data on their copies.

	Temperature	
	Begin	15 min.
Sunny		
Shaded		

   c. Each group is to paint both pans black and let them dry.

   d. They are then to pour 1/3 cup water into each pan, and to measure and record the temperatures of each on the chart. The plastic wrap is to be used to cover the pans tightly. (The wrap should be taped to ensure a tight seal.) One pan is to be set in a sunny area and the other in a shaded area. Both pans should be set on several sections of newspaper to keep the ground's temperature from affecting that of the water. After 15 minutes, each group is to pour the water into the two cups and measure the temperatures.

3. Have the students draw conclusions about the activity. Have them answer the following questions:

   a. Which pan had hotter water?

   b. Why were the pans painted black?

   c. For what purpose was the plastic wrap?

   d. Why pour the water into cups before measuring the temperature?

C. Have the class build simple solar air heaters.

1. Divide the class into groups of five or six students each. Each group is to construct a solar air heater, using the directions on the student sheet "BUILD A SOLAR AIR HEATER," included. Provide each group with cardboard, a yardstick, shellac, flat black paint, paintbrushes, thumbtacks, scissors, duct tape, plastic wrap, a razor knife, and masking tape.

2. When the air heaters have been completed and tested as directed on the student sheet, have the students evaluate the performance of their heaters.

III. Follow-up

A. Have the students demonstrate knowledge of the following solar energy concepts:

1. Explain the seasons. (In winter, the sun is low in the sky and its heat is spread out more—is less intense—than it is in summer. In summer, the sun appears higher in the sky. Its rays are more direct, making the land and seas warmer in the summer that in the winter. These changes are due to the differing tilt of the earth on its axis. In winter the Northern Hemisphere is tilted away from the sun; in summer, it is tilted toward the sun.)

2. Define solar energy, (Solar energy is the energy we get from the sun's rays; it can be used to heat homes or water.)

B. Have the students explain passive solar heating. (A passive solar heating system is one which relies largely on the natural flow of heat to collect and store heat from the sun's rays. It does not have pumps, fans, or other devices to help in this process. Simply put, a passive solar system is a building or a device that traps solar energy for use.)

C. Have the students list some important factors in collecting solar energy (something to trap heat [a collector], a location free from shading, black surfaces to increase heat collection, and so forth).

IV. Extension

A. Some students might collect pictures and newspaper or magazine articles related to solar energy. These should be displayed and a presentation made about them. Some may wish to make a scrapbook on solar energy.

B. Students may make crossword puzzles or word search puzzles about solar energy. These may be duplicated and copies given to classmates or other teachers' students.

C. Students may read books or stories about solar energy. This activity should be completed by one of the following.

1. Designing a poster advertising the books they read.

2. Making a "filmstrip" about the book on a long sheet of white paper. (Adding machine tape works well.)

3. Writing a summary of the book.

D. Some students may wish to research solar energy-related careers. (This may lead to an investigation of possible solar energy applications for the future.

RESOURCES

Fogel, B. Energy Choices for the Future. Franklin Watts. NY: Impact, 1985 (pp. 57–62).

Mallinson, Mallinson, Valentino, and Smallwood. Science-Grade 4. Morristown, NJ: Silver Burdett. 1984 (p.146).

Mason, J. Power Station Sun. East Grinsted, Sussex, England: BLA, 1987 (p. 7).

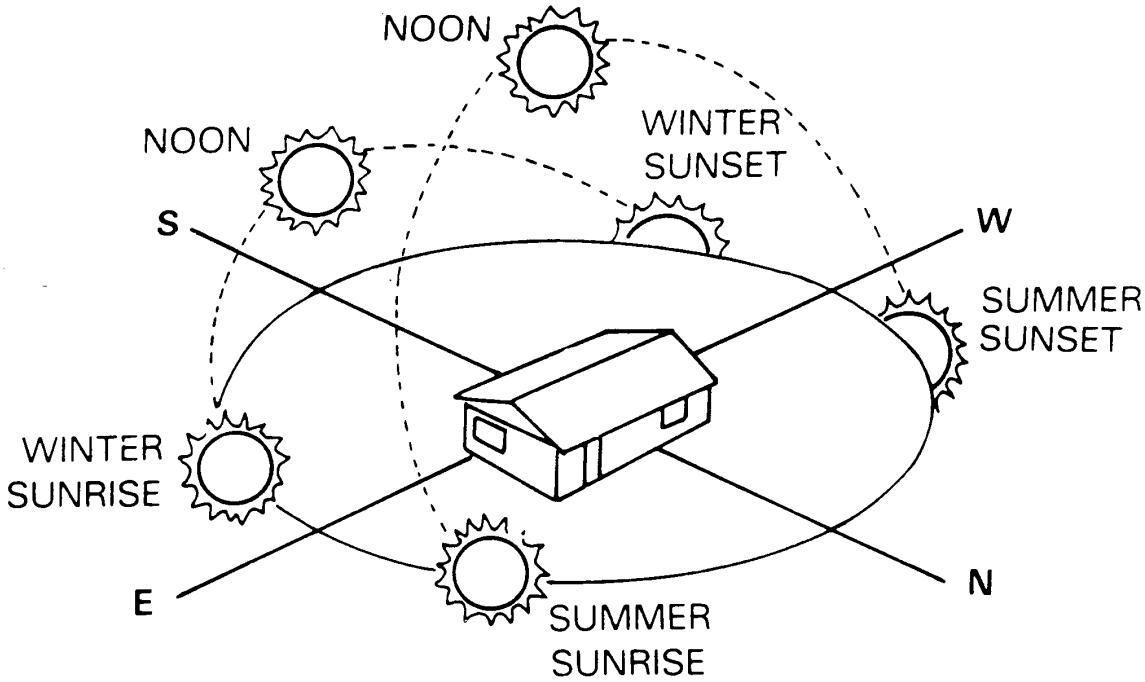
National Appropriate Technology Assistance Service. Connections: A curriculum in Appropriate Technology for 5th and 6th Grades. N.p.: U.S. Department of Energy, 1986. (Address: NATAS, P.O. Box 2525, Butte, MT 59702-2525. Telephone: 1-800-428-2525.)

"Science Scene, Solar Fun." The Mailbox, October 1987.

Spetgang, Tilly, Wells, and Malcolm. The Children's Solar Energy Book. New York: Sterling, 1982. (pp. 65, 89)

Thompson, Hancock, Witte, and Associates. Passive Retrofit Handbook. Atlanta: Southern Solar Energy Center and U.S. Department of Energy, 1980.

THE SUN'S DAILY PATH



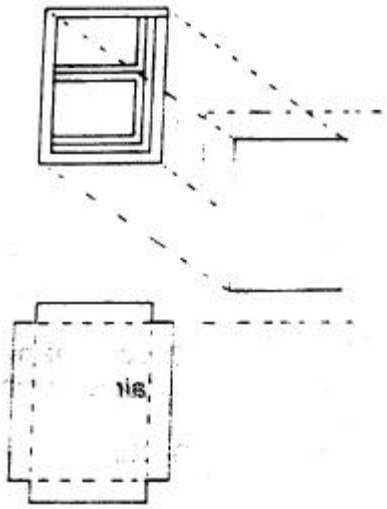
BUILD A SOLAR AIR HEATER*

I. Prepare to build a solar air heater.

A. Use a compass to find a window that faces due south.

B. Measure the window to be used and get a piece of cardboard large enough to cover it with a least 5 inches to spare all the way around.

C. Mark off the exact size of the window on the cardboard. Add 5 inches all the way around the window size and cut out the heater as shown in the diagram.

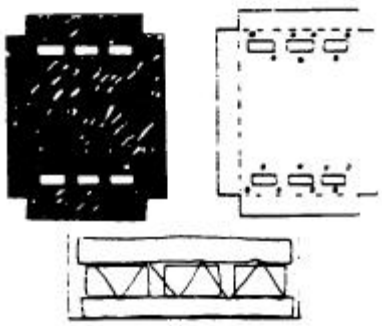


D. Fold back 5-inch flaps and test the box-like heater for a snug fit inside the window frame.

E. Cover one side of the cardboard with shellac. After letting it dry for 5–7 hours, paint it with flat black paint. Let the paint dry completely before going on.

II. Make the vent holes in the heater

A. Cut vents at least 3 inches high near the top and bottom of the heater, as shown.



B. Push thumbtack into the cardboard around the vent holes as shown. (Put them in the unpainted side.)

C. Weave some thin string around the thumbtacks, crossing the vent holes.

D. Cover the thumbtacks with strips of silver duct tape to keep them from falling out.

E. Get some thin plastic film (like food wrap do not use wax paper) and cut strips large enough to cover the vent holes.

BUILD A SOLAR AIR HEATER*

(continued)

F. Tape the plastic to the outside (black side) of the bottom vents and to the inside (string side) of the top vents.

III. Install the heater in the window.

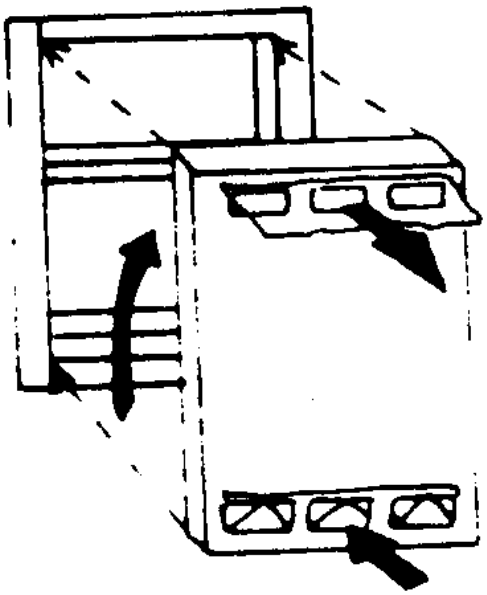
A. Place the heater black side facing the window, top vents up (so that the plastic flaps hang down over the vent holes) inside the window frame. Then tape it to the window frame with masking tape.

B. Leave an air space between the glass and the cardboard, but none around the edges of the cardboard.

C. After the heater has been in place for several class periods, check to see if warm air is coming out of the top vents.

D. Don't leave the masking tape on the window frame too many days; it may pull the paint off with it when you remove it.

E. A smaller model can be made using a cardboard box taped to the window, leaving an airspace between the glass and the back of the box. Just the follow the above directions.



*Adapted from Connections, developed by NATAS. (See the listing of resources at the end of the teacher materials for this activity.)