

Solar Homes and Heat Sinks

Alternative energy sources are energy sources other than the nonrenewable fossil fuels—coal, petroleum, and natural gas. Solar energy, or energy from the sun, is one energy alternative. A passive solar heating system uses no pumps, fans, or mechanical devices. Insulation and heat storage are important factors in such a system. Heat can be stored using thermal masses, also called “heat sinks.” Thermal masses can keep a home from heating or cooling too fast. In this experiment, you will examine the effectiveness of a thermal mass. You will then use what you learn to design and build a model solar home.

OBJECTIVES

In this experiment, you will

- Use a computer to measure temperature.
- Graph temperature data.
- Determine the relationship between thermal mass and the ability of a solar home to retain heat.
- Design and build a model solar home.

MATERIALS

computer
Vernier computer interface
LoggerPro
2 Vernier Temperature Probes
2 model solar homes
tape

empty bottle with “screw-on” cap
room-temperature water
lamp with 100 watt bulb
2 pieces of cardboard to cover the model
solar home windows

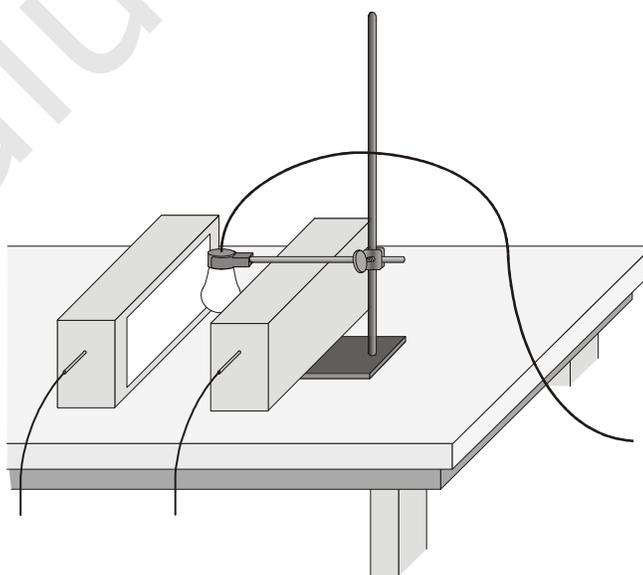


Figure 1

PROCEDURE

Part I

1. Get 2 model solar homes and position them 20 cm apart, with the window sides facing each other.
2. Fill a bottle with room-temperature water. This will be the thermal mass, a material that absorbs and stores heat, for Part I. Firmly tighten the bottle cap and lay the filled bottle inside one of the model solar homes. Leave the other model home empty. Tape both model homes shut.
3. Position a lamp to shine down between the model solar homes as shown in Figure 1. The lamp bulb should be 10 cm above the table top and equidistant from the two model homes. Do not turn the lamp on yet.
4. Position Probe 1 in the model solar home with no thermal mass and Probe 2 in the model solar home with the thermal mass. In both cases, pass 1/2 of the probe through the hole provided and make sure the probe is not in direct light from the lamp.
5. Connect the probes to the computer interface. Prepare the computer for data collection by opening the file “15 Solar Homes” from the *Physical Science w Vernier* folder.
6. You will be collecting data for 80 continuous minutes. During the first 40 minutes, the light will be on. After 40 minutes have passed, the light will be turned off and the windows of the model solar homes will be covered. “Not lighted” data will be collected for 40 more minutes.
7. Click  to start data collection. Turn the light on after the first set of temperature readings appears in the table.
8. After 40 minutes, turn the light off and cover the window of each model solar home with a piece of cardboard. Data collection will end when a total of 80 minutes has passed.
9. Determine the maximum temperature reached in each of the model solar homes:
 - a. Click the Examine button, .
 - b. Move the mouse pointer to the highest point on the Temperature 1 curve.
 - c. The temperature at this point is displayed. Record this Probe 1 (no thermal mass) maximum temperature.
 - d. Move the mouse pointer to the highest point on the Temperature 2 curve.
 - e. Record the Probe 2 (with thermal mass) maximum temperature.
10. Move the mouse pointer to the 80 minute line. Record the two temperatures at 80 minutes.
11. Print copies of the graph as directed by your teacher.

DATA AND CALCULATIONS

Probe	1 No thermal mass	2 With thermal mass
Maximum temperature	_____ °C	_____ °C
Temperature at 80 minutes	_____ °C	_____ °C
Maximum temperature minus temperature at 80 minutes	_____ °C	_____ °C

PROCESSING THE DATA

1. Subtract to find the temperature drop for each model solar home as it cooled from its maximum temperature to its temperature at 80 minutes (maximum temperature – temperature at 80 minutes). Record the differences in the Data and Calculations Table above. Which model solar home cooled more?
2. How are the “no thermal mass” and the “with thermal mass” curves similar? How are they different?
3. Which model solar home heated more slowly?
4. Which model solar home cooled more slowly?
5. What effect does the thermal mass have on the heating and cooling of a model solar home?

6. Is it best for thermal mass to have a high or low specific heat? Explain.

7. The thermal mass took up a large fraction of the space in your model solar home. Would using this much space for thermal mass in a real solar home be a problem? Explain.

8. What are some advantages of heating a home with solar energy?

9. What is a disadvantage of heating a home with solar energy?

Part II Design Problem

1. Using the information you gained in this and other experiments, design and build a model solar home that cools more slowly than the one you tested in Part I.
 - a. Begin with a model solar home like the one used in Part I.
 - b. You may add no more than 3 cm to the thickness of the walls.
 - c. You may use no more than 500 mL of heat sink.
 - d. Your home must have a window with an area of at least 150 cm².
 - e. When testing your model, first use a lamp to raise the inside temperature to equal the maximum temperature inside the “with thermal mass” model in Part I. Then turn off the lamp, cover the window, and monitor temperature for 40 minutes as in Part I.
 - f. Compare the results with your Part I results and the Part II results of your classmates.
 - g. Explain why you chose the materials you did.

EXTENSIONS

1. Run the experiment for two or more consecutive “daily” cycles of four hours or longer.
2. Design an experiment to test other types of thermal mass, such as stones or phase-change materials.
3. Design an experiment to test other variables affecting a solar home, such as color, window material, window size, and insulation type.

Vernier Lab Safety Instructions Disclaimer

THIS IS AN EVALUATION COPY OF THE VERNIER STUDENT LAB.

This copy does not include:

- **Safety information**
- **Essential instructor background information**
- **Directions for preparing solutions**
- **Important tips for successfully doing these labs**

The complete *Physical Science with Vernier* lab manual includes 40 labs and essential teacher information. The full lab book is available for purchase at:

<http://www.vernier.com/cmat/psv.html>



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