

Modeling a Passive Solar Home

Have you ever returned to a car on a cold but sunny day to discover that its interior temperature was warmer than the outside air? The temperature in the car rose as solar energy entered the car through the windows and caused the interior of the car to heat up. Thermal energy accumulated inside the car because it was not able to leave the car readily through the windows in the way the solar energy entered.

Architects and builders sometimes design homes and other buildings to take advantage of this phenomenon. These solar buildings have various features that collect and store the energy from the sun, often eliminating the need for gas, oil, or electric heating. In this laboratory activity, you will build and experiment with models of passive solar homes to find out which features of the houses best utilize the sun's energy.

OBJECTIVES

Design several models of passive solar homes.

Experiment to determine one feature of a passive solar home that will increase the energy efficiency of the home.

Determine how landscaping materials affect the efficiency of a passive solar home.

MATERIALS

- cardboard boxes with lids, identical (2)
- Celsius thermometer (3)
- glue
- indoor insulating materials such as cardboard, foam sheets, caulk, paint, foil, tiles, and/or sheets of construction paper
- knife or single-edged razor blade
- landscaping materials such as water containers, construction paper, small rocks, and/or soil
- metric ruler
- paper
- pencil
- plastic wrap, clear
- tape
- watch or clock
- white poster board, large sheet



Modeling a Passive Solar Home *continued***Procedure****PART I—CONSTRUCTING THE EXPERIMENTAL CONTROL MODEL**

Imagine that you are an architect and that you and the other architects in your firm are asked to design the most effective passive solar home for a top client. Your group will first make a model of a passive solar home to serve as an experimental control.

1. Use one of the cardboard boxes to build a model of a passive solar home. Use the knife or single-edged razor blade to carefully cut out a window that is 5 cm long on each side.
2. Cover the window with the plastic wrap and secure all of the edges of the wrap with tape.
3. Place the thermometer inside the model so that it can be seen and read through the window.
4. Set your model in the sun, positioning it to capture as much solar energy as possible.
5. Record the temperature inside this first model home at the start of this experiment and every 5 minutes thereafter for 30 minutes. Record your measurements in the table below.

INSIDE TEMPERATURES OF TWO PASSIVE SOLAR HOMES

Temperature (°C)	First Model Home	Second Model Home	With Landscaping
Initial			
5 minutes			
10 minutes			
15 minutes			
20 minutes			
25 minutes			
30 minutes			

PART II—IMPROVING YOUR 'MODEL' HOME

You and your colleagues are to work together to design a second model home. For this model, you will agree among yourselves to add only one new feature to improve the home's energy efficiency.

6. Develop a hypothesis about a design feature that you think would best improve your model's passive solar heating capability. Consider the following design features in developing your hypothesis: orientation of the home relative to geographic south, the locations of windows, the surface area of each window,

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skylights, insulation, interior and exterior surface colors and finishes, and energy loss associated with windows. Record your group's hypothesis below.

- 7.** After your teacher has evaluated your hypothesis, describe your proposed design change below.

- 8.** Once you have your teacher's approval, build a second model home to test your hypothesis.
- 9.** Set your second model in the sun, orienting it to face the same direction as your first model. Try to pick a day when the level of sunlight is similar to what it was during your first experiment.
- 10.** Place the second thermometer inside the second model and record the initial temperature in the table. Record the temperature in the data table every 5 minutes as before.

PART III—LANDSCAPING

- 11.** Glue your second model home to a large sheet of white poster board. Use at least three of the suggested landscaping materials (or others of your choice) to create a landscape around the house that you think would aid in the building's solar efficiency.
- 12.** Test the effects of your landscaping by placing the model in the same position as it was in step 9.
- 13.** Use a thermometer to record the initial temperature of the air just above (about 2.54 cm) each of the three different landscaping materials. Continue to measure the air temperature in these spots every 5 minutes for 30 minutes. Remember to record your measurements in the appropriate places in the data table.

Analysis

- 1. Describing Events** How did the temperature data gathered using your first model differ from the data collected using the second model?

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2. Analyzing Data Compare your results with the results of other groups. Were their designs more efficient? If so, what did they do differently? If you could redesign your model yet again, what changes would you make?

3. Identifying Patterns Which of your landscaping materials best contributed to the solar energy efficiency of your second model? Support your answer.

Conclusions

4. Applying Conclusions Why do you think most passive solar buildings have large, south-facing windows?

5. Evaluating Methods Why were you asked to change only one feature when designing your second model home?
