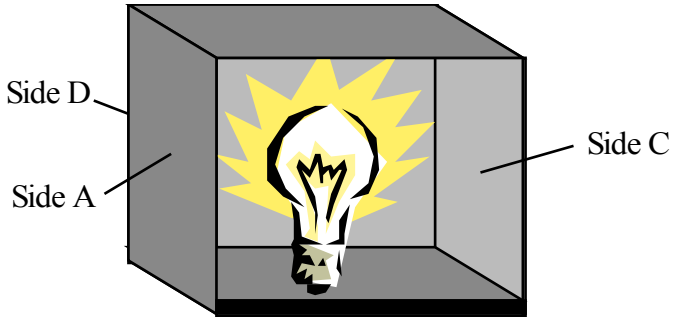
Investigating Insulation

Most of the people living in the United States find it necessary to heat their homes in the winter. Minimizing the rate at which heat is transferred to the atmosphere reduces the amount of heat needed to keep the house warm. To assist with this goal, various materials are used to insulate our homes. A well insulated house will transfer heat slowly to the atmosphere. One way to measure the heat flow is to look at the temperature of the outside walls over time. The cooler the walls, the better insulated the house. Using this premise, you will investigate the ability of different materials to insulate a model house.

OBJECTIVES

In this experiment, you will

- Construct a model house
- Investigate heat transfer through different insulating material



MATERIALS

Infrared Thermometer
Cardboard box for use as a model house
40-watt light bulb in socket
Insulating material for the walls
Ring stand and utility clamp
Black paint (flat not glossy) - optional

PROCEDURE

Building a Model House

1. Make a model house that is roughly a cube. The house needs to be large enough to completely cover the light bulb without the bulb contacting any of the sides or the roof. The roof should be vented but not completely open.
2. Using various insulating material, insulate the four walls of the house. Be sure each wall is insulated differently in some way. In the data table provided, describe the material used to insulate each of walls. Be sure to note which wall is A, B, C and D.
3. If instructed to do so by your teacher, paint the inside and outside walls of your model house using flat black paint.
4. Place the light in the center of your model house. Have your teacher check your house for any safety issues before continuing.

Measuring Heat Flow

5. Turn on the Infrared Thermometer by pressing the MEAS button.
6. Point the sensor at the center of wall A on your model house. Hold the Infrared Thermometer about 10 cm from the wall. Record the temperature of wall A in the data table. Repeat this for the other three walls.
7. Turn on the light. After three minutes, take the temperature of each wall and record the results in the data table.

   CAUTION: *Your model house will become hot. Do not leave the light on for extended periods of time unattended. Be careful when handling the house, especially right after you have finished data collection.*
8. Continue measuring and recording the temperature of each wall every 3 minutes for a total of 21 minutes.
9. Unplug the light bulb and allow your model house to cool.
10. Be prepared to present your results to the class.

DATA

Wall:	A	B	C	D
Description of insulation				
Time (min)	Temperature (°C)			
0				
3				
6				
9				
12				
15				
18				
21				

PROCESSING THE DATA

1. Why is it important to have a model house that is a cube? What variable(s) are you trying to control?

2. Overall, which wall got warm fastest? What conclusion can you draw from this? How does the insulation on this wall compare to the insulation on the other walls?

3. Overall, which wall stayed cool longest? What conclusion can you draw from this? How does the insulation on this wall compare to the insulation on other walls?

4. Based on the class results, describe the insulation you would recommend using if you wanted to minimize the rate at which heat is transferred through the insulation.

5. Based on the class results, describe the insulation you would recommend using if you wanted to maximize the rate at which heat is transferred through the insulation. When might this be useful?

Extensions

1. Extend your experiment to investigate the temperature of the outside walls as the house cools.
2. Investigate various designs for a house. Include houses with various shapes and features (for example, windows).
3. Investigate the heat flow around the outside of your home or school. Identify places where heat loss is a maximum and where it is a minimum.

TEACHER INFORMATION

Investigating Insulation

- The walls can be constructed of cardboard in varying thicknesses – 1 layer, 2 layers, etc. or can be a uniform thickness using different materials for each wall – flat cardboard, corrugated cardboard, Styrofoam, etc.

- Be sure to stay away from clear (exposing the light bulb) or highly reflective materials for the walls of the model house. The Infrared Thermometer will not read the temperature of these surfaces correctly.

- If you live in a warmer climate, discuss how insulation is used to keep the house cool. This can be demonstrated by using dry ice (to simulate air conditioning) instead of the lamp.

- The Infrared Thermometer can be used with a data-collection interface such as a LabQuest or a LabPro with a calculator or computer.

SAMPLE RESULTS

Wall:	A	B	C	D
Description of insulation				
Time (min)	Temperature (°C)			
0				
3				
6				
9				
12				
15				
18				
21				

ANSWERS TO QUESTIONS

1. Having the model house shaped as a cube (with the light placed in the center) keeps one wall from being closer to the light than another. This is an attempt to assure the walls will heat uniformly.

2. Answers will vary. The wall that gets warm fastest conducts heat faster than the other walls.

3. Answers will vary. The wall that stays cool longest conducts heat slower than the other walls.

4. Answers will vary.

