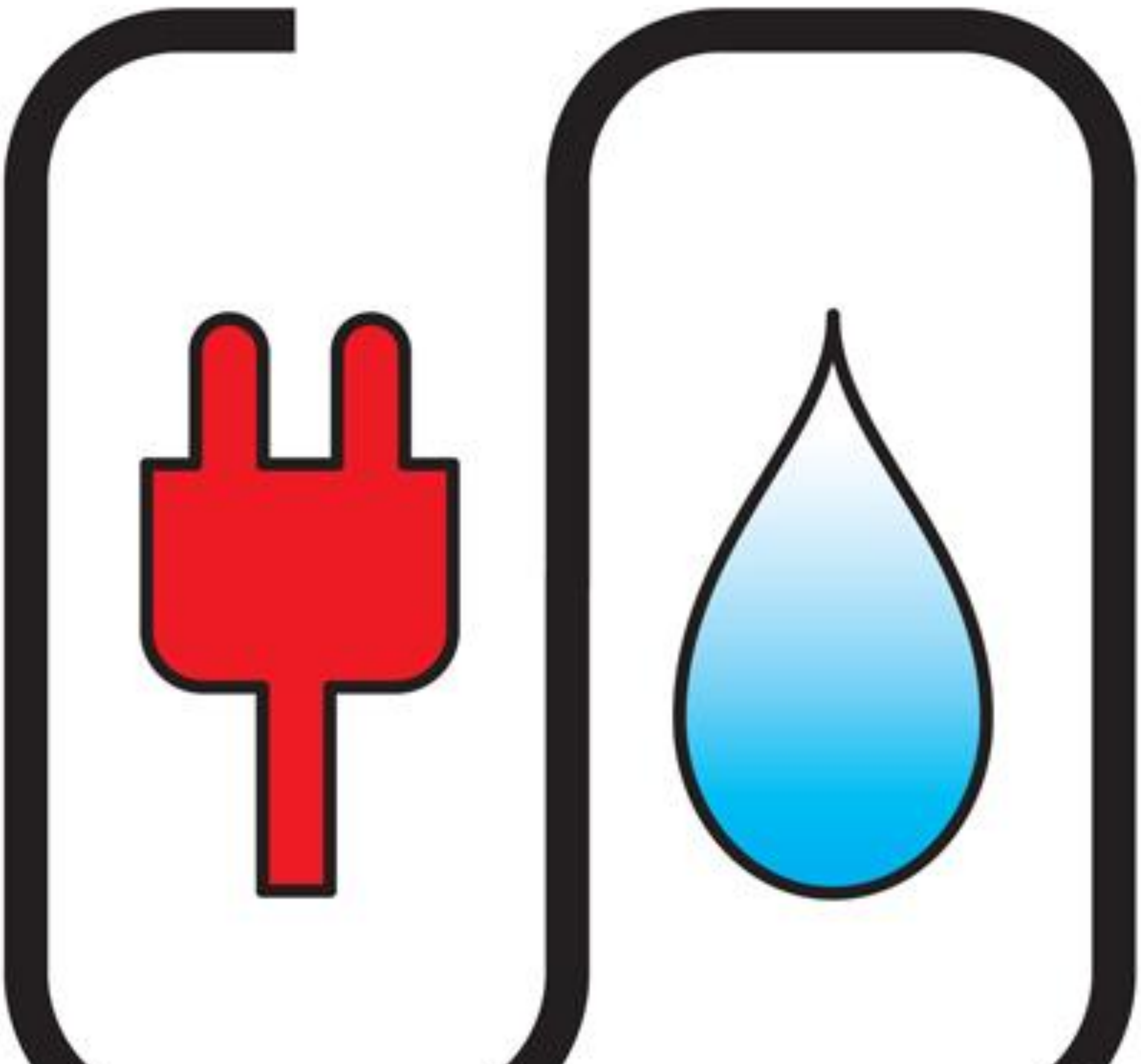
Sustainability: Energy Efficiency

(Green Consulting Unit)



Overview

Walks students through the process of building a model home while considering 11 parameters that influence energy use, such as building orientation, room configuration, building envelope, and energy systems (heating, cooling, lighting, etc.).

Objectives

The students will be able to:

- Use models to learn how to maximize the comfort-conditioning of a home.
- Observe, gather, and analyze data from the model simulations.
- Draw conclusions from the data.

Time

Week 1

Period 1 (M)	Introduction
Period 2 (W)	Activities 1, 2
Period 3 (F)	Activities 3, 4

Week 2

Period 4 (M)	Activities 5, 6, 7
Period 5 (W)	Activities 8, 9, 10, 11
Period 6 (F)	Activities Presentations and conclusion

Materials

The following materials are required throughout the duration of the lessons.

1. Large newsprint pad, drawing paper, several colored pens, rulers, protractor, student sheets (included)
2. Activity 3: cardboard box, piece of white poster board, compass, clear plastic wrap, flat black paint or black construction paper, thermometer, masking tape
3. Activity 4: hot plate, watch, metal stem thermometer (0 - 1000C), large beaker, ¼" thick plywood, ½" thick fiberglass, ceramic tile, 2 plastic straws of different diameter, tape
4. **All units require access to suggested supplemental material – Internet access**

Background Information

Among the factors influencing the energy efficiency of home design are site analysis, home orientation, configuration, envelope, space planning, ventilation, heating, cooling, lighting and appliances, water heating, and waste management. A brief explanation of each of these factors follows.

Site analysis is the recognition and use of natural elements of a home's setting for its energy efficiency. An example might be sitting at home to take advantage of wind breaks to the north. Home orientation includes facing a house and planning its windows to maximize solar heat gain in winter and minimize it in summer.

The home design's configuration should balance the benefits of using natural lighting and minimizing perimeter wall areas. To increase southern exposures (i.e., solar access), the optimal configuration is generally a form elongated in the east-west direction. Envelope considerations include the glass and exterior wall materials selected, as well as structural design.

Good space planning arranges various home activity areas appropriately. For example, the kitchen/dayrooms might share the east/south sides of the home. Ventilation includes the controlled intake of fresh air, its circulation, and its exhaust.

Heating and cooling needs vary widely across geographical regions; for instance, in the northwest and Midwest, heating needs for homes are usually greater than cooling needs. Alternatively, in the southwest and south, cooling needs are usually higher than heating needs. In traditionally cooler areas, home heating generally consumes more energy than any other home energy use category (approximately 40 percent). Heating systems include electric resistance heating (e.g., electric wall heaters), gas furnaces, wood heaters, and electric heat pumps; central heating systems deliver heated air or water to all parts of the home. Heating (and cooling) systems are usually controlled by a thermostat. Cooling systems in homes are almost always windows or central air-conditioners that use a compressor and refrigerant to cool and dehumidify the air inside the home.

Lights and appliances are usually powered by electricity. An exception would be gas stoves. Well designed windows or skylights can be used to provide "day lighting." One factor to consider when purchasing appliances is their energy efficiency rating. The location of appliances within the living space and the ways in which they are used and maintained must also be considered.

Domestic hot water is the term for heater water used for washing and bathing. As much as 25 percent of all-electric home's electricity bill comes from heating water. Energy waste management should always be considered in the design of large buildings. Waste management systems for homes are generally rudimentary. An insulation blanket for a water heater is a simple form of waste management. Another is the fresh air intake control device on heating/air conditioning systems. We will begin to see more frequent use of air-to-air heat exchangers to preheat incoming fresh air as a waste management feature in new systems.

Procedure

1. Give each student a copy of the student sheet "ENERGY-EFFICIENT STRUCTURES - Introduction" included. Using the background information, introduce the eleven factors given for energy-efficient homes to the students. Utilize the attached PowerPoint presentation to supplement lessons. The PP is divided into different categories, but will serve as a reference and/or introductory piece for each activity. Email a copy of the Introduction and PP to students to reduce paper associated with printing.

2. Divide the class into groups. Each group will use the activities to create a presentation. They are to complete the activities and then develop a presentation for the class based on their findings. Encourage them to do further research and to make visual aids. The purpose of the presentation is to develop a convincing "pitch" that would represent one given to clients. The goal is to sell the class on energy efficiency.

3. Allow at least two weeks of class periods to complete this these activities and develop the presentation.
    - Allow one period for students to learn about the eleven factors for energy efficient homes.

Follow-up

I. After the class presentations, some effort should made to compare design features recommended by individual groups for the same design element. For example, compare the south-facing window placement and areas specified by the space planning, ventilation, and configuration. Make a table to compare design features: on the left side write the names of the groups and across the top write the features that groups may have in common (i.e. window placement); fill in the chart as a whole class and discuss differences between groups.

II. You may wish to have a representative from your local utility company, a solar energy advocacy group, or a building or architectural firm visit your class.

Introduction

Energy-efficient structures result from careful consideration of the following design factors:

IV. Site Analysis
V. Home Orientation
VI. Configuration
VII. Envelope
VIII. Space Planning
IX. Ventilation
X. Heating
XI. Cooling
XII. Lighting and Appliances
XIII. Domestic Hot Water
XIV. Energy Waste Management

Nationally, homes tend to consume the following relative amounts of energy for the consumption categories listed.

Heating	**42.5%**
Domestic Hot Water	**14.2%**
Cooling	**11.3%**
Lighting	**6.2%**
Refrigeration	**9.8%**
Cooking	**5.2%**
Clothes drying	**3.2%**

Of course these percentages will vary as locations, homes, heating/cooling systems, appliances, and even the residents' habits vary.

Introductory Reference Materials

- Energy Efficient House Design
- Energy Efficient House Plans
- Green Designs
- Department of Energy: Do-It-Yourself Home Energy Audit
- Attached PowerPoint

Correlated Assignments

As we develop an understanding of new concepts, there will be a correlated assignment for each topic area.

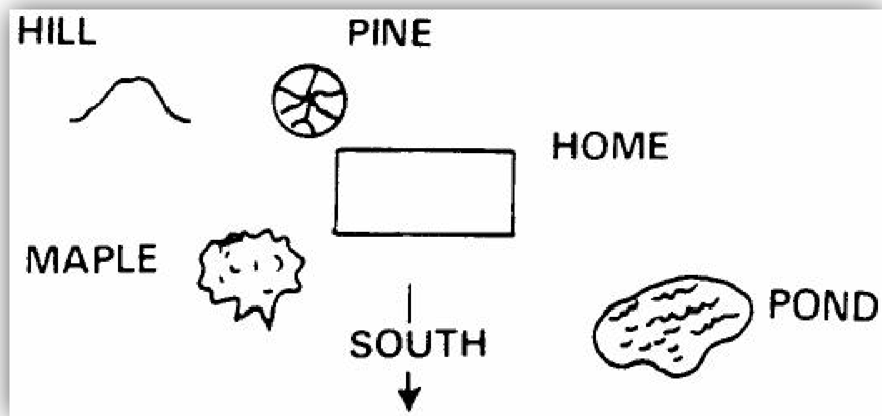
Activity 1: Site analysis

Homes should be sited to take advantage of natural features of the terrain which offer energy conservation help. For example, a home site may offer windbreaks or summer shade. You have probably heard how one can use the sun's energy to heat a home. To benefit from the winter sun's heat, trees near the south wall of your home should be deciduous. Using your personal knowledge, perform the following procedure. Afterwards, at home or in the library, you may gather additional information to substantiate your conclusions.

1. List terrain features that can help to make a home more energy efficient.

2. Explain how each feature can contribute to energy efficiency.

3. Visit the site of a new house or housing development. Examine the siting of the home(s). Draw a map showing compass directions, a new home, and natural features which make the new home more energy efficient. The map need not be elaborate. Here's an example:



4. Describe the new home.

5. Using a different color pen, add to your map the landscaping changes you would make to improve the home’s energy efficiency.

Activity 2: Home Orientation

The sun can help heat our homes in winter. If we use air-conditioning in summer, the sun can increase our energy use and bills unless we provide sun controls. Sun controls which objects might be used include (deciduous) shade trees, roof overhangs, windows blinds and drapes, and thermal insulation. If the south-facing glass area is limited to approximately 10 percent of the comfort-conditioned living space area in a house, there should be more winter energy savings than summer losses (i.e., a net decrease in annual energy used for heating and cooling). Using your personal knowledge, perform the following procedure. Afterwards, at home or in the library, you may get additional information to substantiate your conclusions.

Discussion Questions

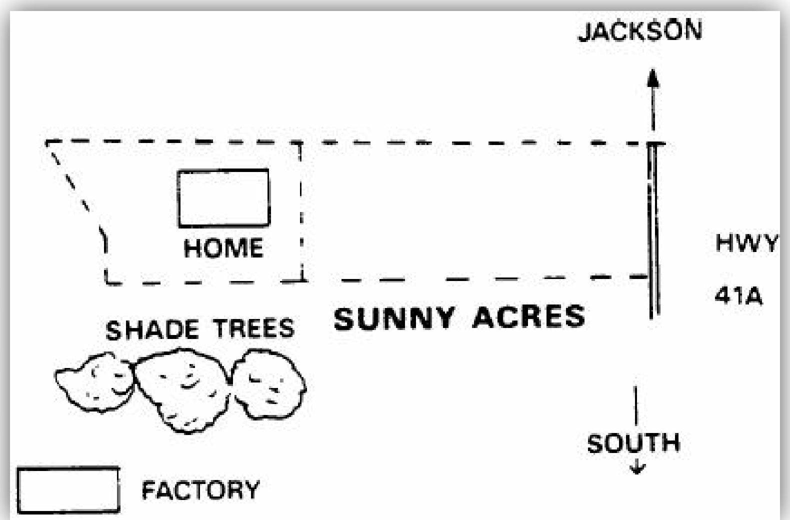
1. List the uses of windows.

2. Think about the position of the sun relative to your location. Describe summer sun positions at daybreak, noon, and sunset. Describe winter sun positions at these same times.

3. If you were a real estate developer and you wished to develop a subdivision in which the homes are designed to maximize energy conservation, you would have to orient the houses properly. Draw a simple aerial map showing the compass directions and the meadows and hills where you will construct the "Sunny Acres" Subdivision. Draw the nearest road that leads into town.

4. Now, plan the access streets which will lead to the main road and select the lot on which you will build your own new home.

5. Draw your new home on the map. Your map may look something like this one.

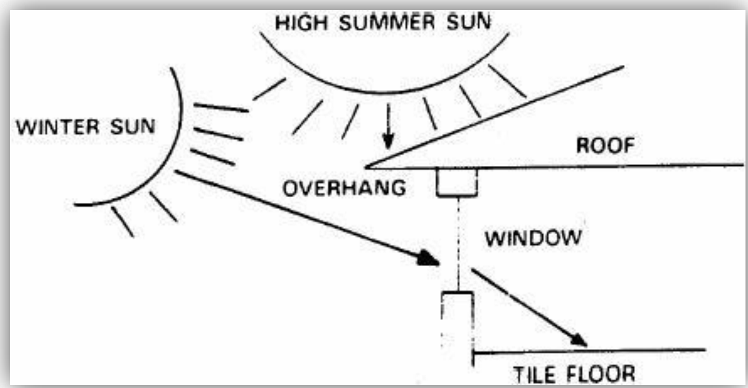


6. Mindful of your household activities and your intention to use heat from the sun, sketch a simple floor plan showing the walls, doors, and windows of your new home.

7. How will you prevent unwanted summer sun from entering the windows? How will you prevent heat loss through the windows during winter? Identify special features you wish to include.

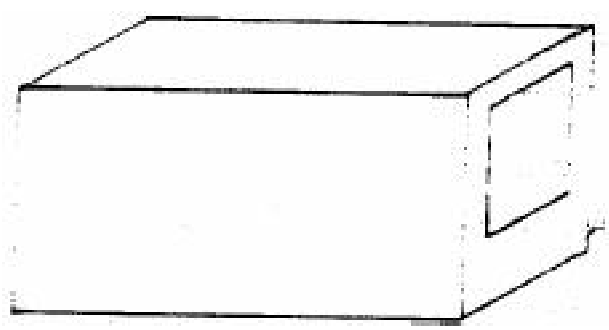
Activity 3: Configuration

People have long been aware of the heating effects of the sun. Utilizing the sun's heat in the winter and avoiding it in the summer helps to cut down on heating and cooling costs. Structures can be designed to conserve energy in both winter and summer. This investigation considers the manipulation of a "roof overhang" to illustrate using a shading device to promote the natural cooling of a house.



Perform the following procedure and log your data on the data sheet. Refer to the provided drawings for guidance. Be prepared to demonstrate this experimental procedure during the class presentation.

1. Cut a hole in one side of a cardboard box. This will be a window. Make sure the window is placed closer to the top of the box than it is to the bottom.

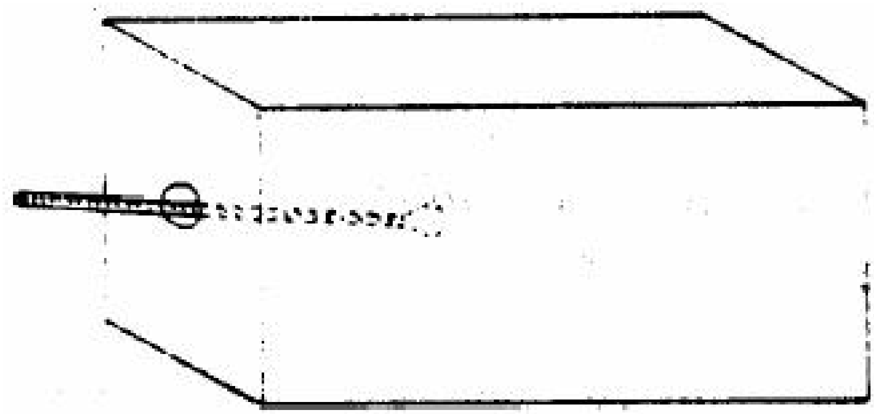


2. Paint all the inside surfaces of the box flat black (or cover them with black construction paper).

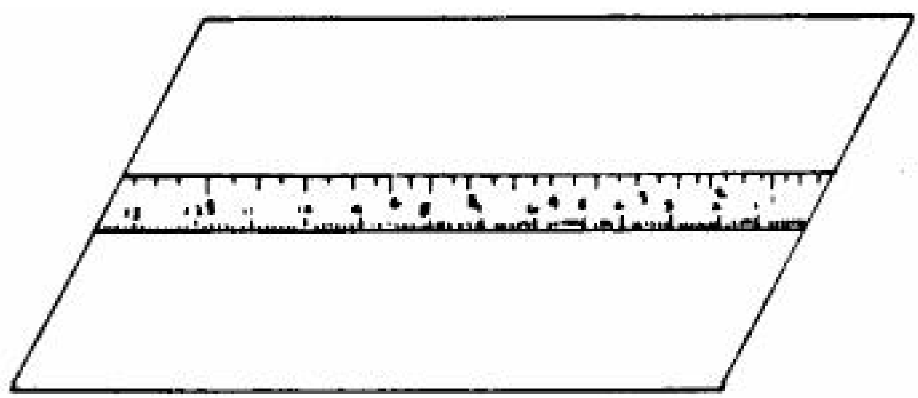
3. Cut a piece of white poster board for the roof long enough to make sure the roof covers the entire box and extends over the edge to completely shade the window.

4. Use plastic wrap to cover and seal the hole in the side of the box. Tape the plastic around the edges.

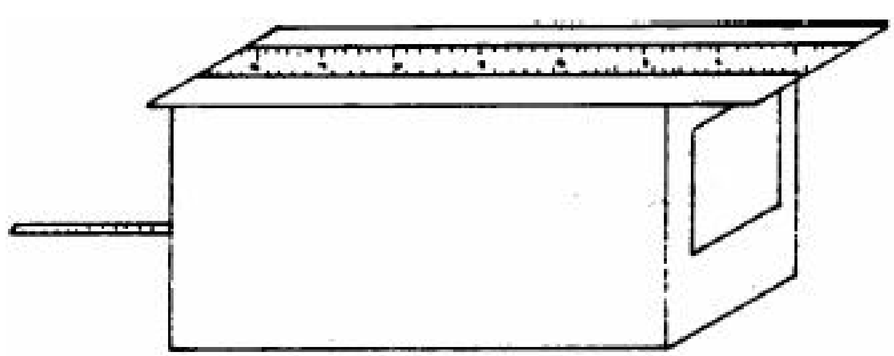
5. Make a small hole toward the back of the box. The hole should be large enough to insert the thermometer. Make sure the bulb of the thermometer is measuring the temperature in the box. It should not be in direct sun light.



6. Tape a ruler to the "roof" piece. This will allow you to easily measure the amount of roof over hang.



7. Set this model "house" up outside in direct sunlight around midday. The window should be facing south.



8. Place the roof so that the window is completely shaded. Wait about 5 minutes (until the temperature has stabilized) and record the temperature in the box. Also record the air temperature outside the box.

9. Move the roof a few centimeters at a time, so that the window is shaded to the different degrees given in the data table. Each time record the temperature after it stabilizes. Do this until you have measured the temperature of the box when its window is in full sun. Be sure to measure and record the outside air temperature, too.

DATA TABLE		
Amount of roof overhang(cm) when shading:	Temp. Inside (^0C)	Temp Outside (^0C)
all of the window --------- cm	----------------	-------------------
3/4 of the window --------- cm	----------------	-------------------
1/2 of the window --------- cm	----------------	------------------
1/4 of the window --------- cm	----------------	------------------
none of the window--------- cm	----------------	------------------

10. Estimate the width of roof overhang needed in your state by sketching to scale the south wall (assume the whole wall to be a window) and determining the roof overhang needed when the noon sun is 75 degrees above the horizon. For this exercise, assume the roof is a flat one as in the model.

Discussion Questions

1. Is roof overhang important for north-facing windows? Would your answer be different if you were living in Australia?

2. From the estimate you made of roof overhang needed in this region, what can you deduce about the placement of deciduous shade trees to the south?

3. Think about the way the sun seems to move from east to west during a day. What can you say about shade tree placement to diminish afternoon sun?

Activity 4: Envelope

It is important to "weatherproof" a home, that is, to insulate, to caulk, and to weatherstrip doors and windows. Insulation is any material that slows the movement of heat from one place to another. It slows the flow of heat entering the house during the summer; it slows the flow of heat leaving the house in the winter. The effectiveness of insulation in slowing the flow of heat is measured in resistance or "R-value." The higher the R-value, the better the insulating potential. Both thickness and composition are important factors in insulating effectiveness. For example, fluffy fibrous insulations should not be compressed before or during installation. In this experiment you will compare the effects of both thickness and composition on insulating capability.

1. Turn on the hot plate. If it has a "warm" setting, use it. Measure the stabilized hot plate temperature with a metal stem thermometer (0 - 1000C) and record it in the data table.

2. Measure and record the thickness of the ceramic tile. Lay it on the hot plate.

3. Measure and record the tile's top surface temperature each minute for 5 minutes. Now take readings every 2 minutes for 10 minutes. Take a final reading 5 minutes later. Record all the temperatures in the data table. Remove the tile from the hot plate using heat-protective gloves.

4. Measure and record the thickness of a piece of plywood. Lay it on the hot plate. Record the temperatures as you did for the tile.
5. Measure and record the thickness of a piece of fibrous insulation bat. (If you are using fiberglass, wear gloves when handling it.) Heat the insulation, measuring and recording the insulation's top surface temperature after 3, 6, 9, 12 and 15 minutes.

6. As a home assignment, plot the surface temperatures of the tile, plywood, and insulation as a function of time. Which surface's temperature rises faster?

7. Place beaker of water on the hot plate and heat it until the temperature of the water stabilizes. While the water is heating, make an insulating sheath by inserting a smaller diameter straw inside another one, folding the straws at their midpoint and wrapping tape around them to hold the ends together.

8. Insert the thermometer into one of the open ends of the straw sheath, and place the apparatus in the beaker of water. Use a watch to time how long it takes the temperature measured by the thermometer to equal the water’s temperature.

9. Turn off the hot plate.

10. Explain why the insulating sheath you made of straws worked.

Stabilized Hot Plate Temperature _______°C

Ceramic Tile		Plywood	
Thickness: ___________ cm		Thickness: ___________ cm	
Elapsed Time (minutes)	**Temp (°C)**	**Elapsed Time (minutes)**	**Temp (°C)**
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Insulation	
Thickness: ___________ cm	
Elapsed Time (minutes)	**Temp (°C)**
3	
6	
9	
12	
15	

Water

Water Temperature: ____________ °C

Time required to reach water temperature (above) when insulating sheath is used: _________ minutes

Discussion Questions

1. How well does the tile conduct the heat of the hot plate? Would tile be useful as insulation? Why or why not? What about the plywood?

2. How do you think the thickness of the insulation bat affects its insulating ability?

Reference Materials

- Department of Energy: Insulation in crawl spaces
- Department of Energy: Adding insulation to an existing home

Activity 5: Space Planning

The sun's warmth and light can make a good house even better. Think about your own family's activities and then design the interior room arrangement of an energy-efficient, passive solar home, performing the following procedure. Afterwards, at home or in the library, gather additional information.

Discussion Questions

1. Where in the house are family members in the morning, at mid-day, in the evening, and at night? What kind of space and comfort-conditioning do they need at these times?

2. Draw a floor plan, showing compass directions, for a new home. Lay out the general arrangement, locate doors and windows, and then partition the space into rooms and storage spaces. Don't forget the need for convenient emergency exits and good traffic flow patterns.

3. Suggest construction materials (e.g., wood paneling, brick, tile), wall colors (e.g., light, dark, warm, cool), and lighting types to maximize the convenience, comfort, and energy conservation of your floor plan.

Reference Materials

- Build it Green: Site and Space Planning/Design

Activity 6: Ventilation

Home ventilation is the controlled intake of fresh air, its circulation, and its exhaust. Average home construction results in inside air being exchanged one time each hour. Tight construction can reduce this to perhaps one-half an air change per hour. Fresh air enters the house through windows, doors, intake louvers on comfort-conditioning equipment, and infiltration or leakage. Many new homes have kitchen and/or bathroom exhaust fans which tend to induce a flow of outside air by reducing inside pressure slightly. Outside air is sometimes supplied to the fireplace grate. Vents are always included in attic or crawl spaces to reduce humidity.

Discussion Questions

Using your personal knowledge, perform the following procedure. Afterwards, at home or in the library, gather additional information to substantiate your statements.

1. Draw the floor plan of a new house to approximate scale, noting on your drawing the compass directions and the length, width, and height of your home (you need not show inside room partitioning unless the ceiling height in the house is not uniform), Calculate the amount of floor space in the home and its total air volume. Relate the air volume to anticipated air changes.

2. Make a fairly complete list of places where air leakage is likely. What are the remedies for each leak?

3. Discuss different types of windows and doors and rate them for their likelihood to cause air leakage.

4. Where could fixed glass windows (i.e., windows that don't open) be used effectively? Look up in the dictionary the word "clerestory," noting both its meaning and pronunciation. Clerestory windows are often used in conjunction with "cathedral" ceilings. They do one thing exceptionally well. Can you think what that might be?

5. Describe what is meant by "cross-ventilation."

Reference Materials

- New York State Energy And Development
- Oikos: Home Ventilation Standards
- Environmental Protection Agency

Activity 7: Heating

Using your personal knowledge, perform the following procedure. Afterwards, at home or in the library, find information to substantiate your choice. You may be able to get a fast overview of heating system types by talking to a heating contractor.

Discussion Questions

1. Using the following outline, briefly describe some of the heating systems. Give both their advantages and disadvantages.

Room Heaters

- electric resistance
- wood
- gas
- oil
- coal
- solar

Central Heating Systems (circulating heated water or warm air)

- electric resistance
- heat pump
- gas
- oil
- coal
- wood

2. Discuss the relative costs of these systems, their efficiencies, and their maintenance requirements.

3. Discuss the likely availabilities and costs of the above fuels during the lifetimes of these systems.

4. Select a heating system for a new home. If you were building a home for yourself, what kind(s) of heating would you use? Why?

Reference Materials

- PDF: Selecting a Home Heating System
- Do it Yourself
- About.com: Home Heating
- Department of Energy

Activity 8: Cooling

Homes often have window air-conditioners or central air-conditioning systems, which use compressors and refrigerants to cool and dehumidify inside air. Using your personal knowledge, perform the following procedure. Afterwards, at home or in the library, gather additional information to substantiate your choice.

Discussion Questions

1. How would you describe the summer climate? Does it vary widely from east to west? If so, why? Does it vary widely from north to south?

2. Discuss what you know about relative humidity and compare the relative humidities of a steam bath or sauna, a summer baseball game, and a cave. What happens when warm, moist air is suddenly cooled? What happens when you go outside on a cool, breezy day with wet hair?

3. Air conditioners and heaters are usually controlled by thermostats. Do you know how your parents control their cooling system? Do family members agree on daily settings for the cooling system control? If no one will be home, is it economical to leave your air conditioner running?

4. What do you know about heat pumps? They can be thought of as reversible air conditioners, supplying cool air in summer and warm air in winter. Because they use refrigerants, heat pumps can absorb heat from cool air in winter effectively. (You won't need to select a separate air conditioner if the "Heating" group selects a heat pump).

5. Compare the efficiency of different brands of air-conditioners. To do this, you will need to compare their Energy Efficiency Ratio (EER). The Energy Efficiency Ratio is defined as the rate at which the device removes heat from the surroundings. It is usually expressed in British thermal units (Btu) per hour divided by the rate of energy input (watts) required to operate the machine. Select a group member to call one or two appliance stores to find out what typical EERs are (not brand names also) and what the expected annual operating costs might be (they may not know this).

6. It is important not to have more air-conditioning capacity than is needed. It is better to have one that runs more and, in doing so, removes more humidity. Make sure the appliance dealers take the energy efficiency of your house into account when sizing a cooling system for it. Air conditioners are often rated in tons. A ton of air-conditioning is usually expressed as 12,000 Btu per hour. A window air conditioner may range in size from 3/4 ton to two tons. Find out what size was most often used in houses that are now 15 to 20 years old. Find out what size is most often used in newly completed houses of about the same size.

7. Select a cooling system from among those you have researched.

Reference Materials

- Energy Star: Cooling
- Department of Energy
- HomeTips

Activity 9: Lighting and Appliances

The category "Lighting and Appliances" usually accounts for just over 20 percent of the energy consumption in an average all-electric home. Typically the big three users are **heating (44 percent)**, **hot water (22 percent)**, and **cooling (12 percent).** Lighting consumes about 10 percent of the electricity used in a typical home. The lesser three are refrigeration (5 percent), cooking (4 percent), and clothes drying (3 percent).

Your job is to select a new home lighting system, explore ways to select energy-efficient appliances, and make suggestion for managing home energy use wisely. Perform the following procedure. Afterwards, at home or in the library, gather additional information to substantiate your conclusions.

Although sharp changes in light intensity should be avoided, adequate light should be directed to areas that especially need it, e.g., where people read, at a work bench, or on the kitchen counter. Fluorescent lighting tends to be cooler than incandescent lighting and about twice as efficient. The term "cooler" means both cooler in terms of temperature and in having a cooler appearance to the eye. Mixing in some incandescent lighting produces a warmer, cheerier look. With these things in mind, and supplying personal knowledge and opinion, design a lighting system for a new home. Draw a sketch showing light fixture placement in the kitchen, the living room, and a bedroom. Try to decide what light-related qualities wall and floor coverings should have. Don't forget to consider window placement and how it will affect lighting needs.

If you want a general estimate of how much electricity your home appliances consume, you can refer to the list below, which provides the energy consumption (Wattage) of some typical home appliances. If you have appliances that are not listed in the table, or desire a more exact figure based on a specific appliance in your home, use the following formula to estimate the amount of energy a specific appliance consumes:

$$\frac{\text{Wattage ´ Hours Used Per Day}}{1000}$$

= Daily Kilowatt-hour (kWh) consumption

(1 kilowatt (kW) = 1,000 Watts)

Multiply this by the number of days you use the appliance during the year for the annual consumption. You can then calculate the annual cost to run an appliance by multiplying the kWh per year by your local utility's rate per kWh consumed. ***For example:***

Window fan:

$$\frac{\text{200 Watts ´ 4 hours/day ´ 120 days/year}}{1000}$$

= 96 kWh ´ 8.5 Cents/kWh

= $8.16 /year

Personal Computer and Monitor:

$$\frac{\text{(120+150) Watts ´ 4 hours/day ´ 365 days/year}}{1000}$$

= 394 kWh ´ 8.5 Cents/kWh

= $33.51/year

You can usually find the wattage of most appliances stamped on the bottom or back of the appliance, or on its "nameplate." The wattage listed is the maximum power drawn by the appliance. Since many appliances have a range of settings (for example, the volume on a radio), the actual amount of power consumed depends on the setting used at any one time.

Here are some examples of the range of nameplate wattages for various household appliances:

- **Coffee maker** = 900-1200
- **Clothes washer** = 350-500
- **Clothes dryer** = 1800-5000
- **Dishwasher** = 1200-2400 (using the drying feature greatly increases energy consumption)
- **Electric blanket-** *Single/Double* = 60 / 100
- **Fans**
  - **Ceiling** = 65-175
  - **Window** = 55-250
  - **Furnace** = 750
  - **Whole** house = 240-750
- **Microwave oven** = 750-1100
- **Water heater** *(40 gallon)* = 4500-5500
- **Water pump** *(deep well)* = 250-1100
- **Personal Computer**
  - CPU - awake / asleep = 120 / 30 or less
  - Monitor - awake / asleep = 150 / 30 or less
  - Laptop = 50
- **Refrigerator** *(frost-free, 16 cubic feet)* = 725
- **Televisions**
  - 19" = 65-110
  - 27" = 113
  - 36" = 133
  - 53"-61" Projection = 170
  - Flat Screen = 120
- **Toaster** = 800-1400
- **Vacuum cleaner** = 1000-1440

Refrigerators, although turned "on" all the time, actually cycle on and off at a rate that depends on a number of factors. These factors include how well it is insulated, room temperature, freezer temperature, how often the door is opened, if the coils are clean, if it is defrosted regularly, and the condition of the door seals. To get an approximate figure for the number of hours that a refrigerator actually operates at its maximum wattage, divide the total time the refrigerator is plugged in by three.

If the wattage is not listed on the appliance, you can still estimate it by finding the current draw (in amperes) and multiplying that by the voltage used by the appliance. Most appliances in the United States use 120 volts. Larger appliances, such as clothes dryers and electric cooktops, use 240 volts. The amperes might be stamped on the unit in place of the wattage. If not, find a clamp-on ammeter—an electrician's tool that clamps around one of the two wires on the appliance—to measure the current flowing through it. You can obtain this type of ammeter in stores that sell electrical and electronic equipment. Take a reading while the device is running; this is the actual amount of current being used at that instant.

Also note that *many appliances continue to draw a small amount of power when they are switched "off."* These "phantom loads" occur in most appliances that use electricity, such as VCRs, televisions, stereos, computers, and kitchen appliances. Most phantom loads will increase the appliance's energy consumption a few watts per hour. These loads can be avoided by unplugging the appliance or using a power strip and using the switch on the power strip to cut all power to the appliance.

Discussion Questions

1. Select one appliance that uses a lot of energy and find out (1) if annual average energy use for different brands are available, (2) how three brands with the same features compare in energy consumption, and (3) if the number given in this table is reasonably accurate.

2. For the appliance selected, list some measures which, if followed, will reduce its energy consumption.

Reference Materials

- Energy Star: Appliances
- AchieveGreen.org: Carbon Calculator

Activity 10: Domestic Hot Water

The average family uses approximately 5,400 kilowatt hours of electricity in a year to heat water. Using your personal knowledge, perform the following procedure. Afterwards, at home or in the library, gather additional information to substantiate your conclusions

Here are some ways to reduce the energy consumed by heating water:

- Fix leaking faucets
- Use shower flow restrictors.
- Insulate your water heater.
- Set the water heater thermostat at a lower temperature, if possible.
- Take showers instead of baths
- Take cooler showers and make them short.
- Try washing clothes with cold water.

Discussion Questions

1. List the advantages and disadvantages of the following kinds of water heaters.

   - Electric water heater
   - Gas water heater
   - Heat pump water heater
   - Simple solar preheater for water (water runs through a garden hose inside a solar collector box before filling the water heater)
   - Solar water heater

2. If an electric water heater uses 5,400 kilowatt-hours annually and a natural gas water heater uses 25,000 cubic feet of natural gas, determine how much each will cost to run annually. Your local gas and electric utilities can help you.

3. Select a water heater for a new home and explain your choice.

Reference Materials:

- Energy Efficient Rehab Advisor
- US Department of Energy (Solar Water Heaters)
- PDF: Types of Solar Domestic Hot Water Systems
- DIYWiki

Activity 11: Energy Waste Management

Managing energy use and waste in the home can be a difficult subject to understand. Three important elements of energy waste management are preheating, heat exchanging, and recycling. Although these are most commonly thought of as being practical for industries, large buildings (like schools and office buildings), and other large energy consumers, homeowners can benefit from energy waste management, too. From your personal knowledge, answer the following questions. Afterwards, at home or in the library, gather additional information for your presentation.

1. There are a few uses of preheating in the home. One example is a passive solar water heater which preheats water before filling the water heater with it. Another example is taking frozen food from the freezer and letting it thaw on its own before cooking it; this saves cooking time and energy. Can you think of any other examples of preheating?

2. A heat exchanger is a device by which heat is transferred from one material or fluid to another. For example, an automobile radiator is a heat exchanger by which a water/antifreeze mixture, used to cool the engine, loses waste engine heat to outside air forced through radiator passages. The water is cooled for re-use by outside air. However, most of the heat picked up by the outside air is not used. How does the automobile use some of it?

3. Are there heat exchangers in the house? How does the air conditioner cool household air? How does the heat pump heat inside air? What other heat exchange applications in the home can you list?

4. List materials used in or around the home which can be recycled. List materials found in your garbage can, which can be recycled.

5. Would you recommend any energy waste management system for a new home? Rate their costs by using the following comparisons: (a) How would the systems compare in cost to a central heating and cooling system? (b) How would they compare in cost to a refrigerator? (c) How would they compare in cost to a water heater?

Reference Materials

- Waste Management: Waste to Energy
- Department of Energy
- Home Energy Magazine: Waste Not