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ABSTRACT

This student manual presents a training program designed to educate students and individuals in the importance of conserving energy and to provide for developing skills needed in the application of energy-saving techniques that may result in energy efficient buildings. Alternatives are provided in this program to allow for specific instruction in energy-saving methods and procedures, or for integration with construction courses. It may also be used for self-paced instruction. The materials are divided into three parts: (1) Understanding and practicing energy conservation: (2) Determining amount of energy lost or gained in a building: and (3) Determining which practices are more efficient and installing materials. (Author/DS)

DOE/R/00086-1 Pt. 5

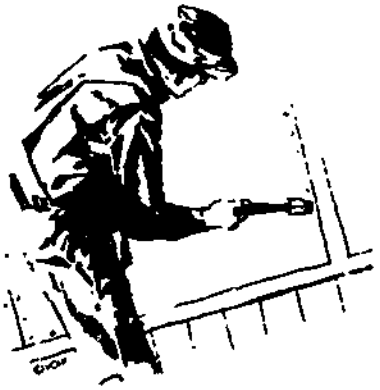
Prepared for the U.S. Department of Energy

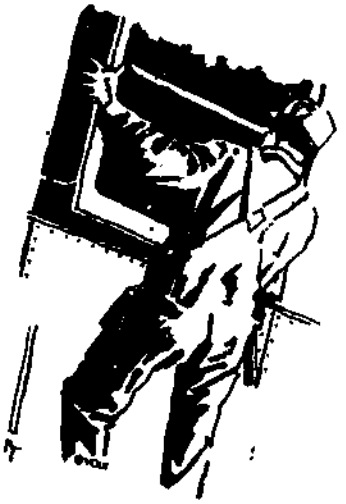
June 1980

Office of Consumer Affairs
Education Division
Washington, D.C. 20585

Providing for Energy Efficiency in Homes and Small Buildings

Student Workbook





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Contents

PREFACE

This Student Workbook parallels the basic manual, PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS:

PART ONE: UNDERSTANDING AND PRACTICING ENERGY CONSERVATION IN BUILDINGS

PART TWO: DETERMINING AMOUNT OF ENERGY LOST OR GAINED IN A BUILDING

PART THREE: DETERMINING WHICH PRACTICES ARE MOST EFFICIENT AND INSTALLING MATERIALS

The Teacher Guide gives answers to questions in the Student Workbook and directions for special exercises and problems related to the subject. It is suggested that the teacher use this guide in preparing lesson plans and teaching the course. An audiovisual paralleling the manuals is available from AAVIM. Write for prices.

Part One:
UNDERSTANDING AND PRACTICING ENERGY CONSERVATION IN BUILDINGS

I. Understanding the Importance of Energy

A. What is Energy?

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part One, Pages 1-25)

STUDENT STUDY GUIDE OR TEST:

Circle letters representing correct answers, unless instructed otherwise.

1. Match the energy conversions with the examples given:

   __a. Mechanical to electricity.
   __b. Chemical to light.
   __c. Light to heat.
   __d. Electricity to heat.
   __e. Light to electricity.
   __f. Chemical to heat.

   1. A solar collector.
   2. An electric generator.
   3. A solar cell.
   4. An electric burner.
   5. A burning candle.
   6. A gas stove.

2. If you touch a warm radiator, the heat you feel is due to:

   a. Convection.
   b. Radiation.
   c. Conduction.
   d. Absorption.

3. A candy bar, a can of oil and a water tower are all conditions of:

   a. Permanent energy.
   b. Kinetic energy.
   c. Converted energy.
   d. Potential energy.

4. Energy from various sources is <u>most</u> useful to us when it:

   a. Is stored permanently.
   b. Gives off heat.
   c. Can be converted from one form to another.
   d. Is used to produce electric power.

5. The major form of energy loss or waste is usually in the form of:

   a. Light.
   b. Heat.
   c. Motion.
   d. Sound.

6. Place a <u>1</u> in front of the statements which explain the First Law of Thermodynamics and a <u>2</u> on the line in front of the statements which explain the Second Law of Thermodynamics.

   __a. Energy in new forms has the same amount of energy in the previous forms.
   __b. Energy loses some of its usefulness each time it is converted to another form.
   __c. Energy input is usually greater than energy output.
   __d. Energy can neither be created or destroyed.
   __e. The more energy conversions in a system the lower the efficiency.

B. What Are the Primary Known Sources of Energy?

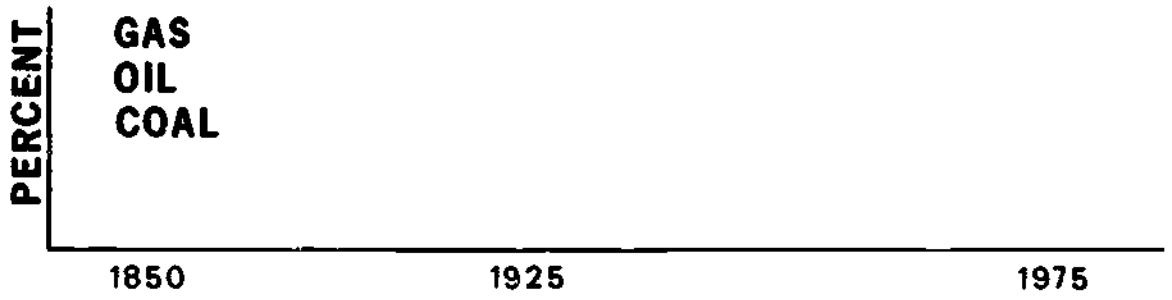
(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part One, Page 26)

STUDENT STUDY GUIDE OR TEST:

1. Label the following sources of energy as either R renewable or N nonrenewable.

   __a. Coal.
   __b. Natural gas.
   __c. Sun.
   __d. Oil.
   __e. Water.
   __f. Uranium.
   __g. Wood.

2. Make a graph showing the type and relative use of three major energy sources used in the United States between 1850 and 1975.



C. What Are the Major Uses of Energy?

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part One, Page 27)

STUDENT STUDY GUIDE OR TEST:

Circle letters representing correct answers, unless instructed otherwise.

1. Approximately what percent of the total energy consumption is used by each of the following sectors of our economy?

Transportation	a.	percent
Residential	b.	percent
Commercial	c.	percent
Industrial	d.	percent

2. Each individual should be concerned with _____ of energy.

3. Two factors which greatly influence the use of energy in buildings are:

   a. Insulation.
   b. Thermostat settings.
   c. Paint.

A. How Long Will the Present Supply of Fossil Energy Last?

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part One, Pages 30-32)

STUDENT STUDY GUIDE OR TEST:

Circle letter representing correct answer, unless instructed otherwise.

1. Energy consumption in the U.S. is increasing at the rate of about:

   a. 2 percent per year.
   b. 5 percent per year.
   c. 10 percent per year.
   d. 20 percent per year.

2. While the U.S. has only ___ percent of the world's population, it consumes ___ percent of the world's energy supply.

3. The U.S. presently imports about:

   a. 20 percent of the fossil fuels it uses.
   b. 30 percent of the fossil fuels it uses.
   c. 40 percent of the fossil fuels it uses.

4. It seems that the most abundant fossil or mineral fuel available in the U.S. is:

   a. Coal.
   b. Oil.
   c. Natural gas.
   d. Uranium.

B. What Are the Prospects for Alternate Sources of Energy?

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part One, Pages 33-40)

STUDENT GUIDE OR TEST:

Circle letters representing correct answers, unless instructed otherwise.

1. How long would proved reserves of natural gas last at the current rate of use?

   a. Twenty years.
   b. Ten years.
   c. Four years.
   d. None of these.

2. Which is presently the least expensive fossil fuel?

   a. Gasoline.
   b. Oil.
   c. Natural gas.
   d. Coal.

3. For the short term, our reliance for energy would seem to be on _____ and _____.

4. For the years 2000 to 2025, which of the following sources of energy will see the U.S. through its energy crisis?

   a. Coal.
   b. Solar.
   c. Nuclear.
   d. Natural gas.

5. One major limitation to nuclear power as a source of energy is the limited supply of the mineral _____.

6. In which of the following areas does the present development of solar energy best lend itself?

   a. Electrical generation.
   b. Space and water heating.
   c. Pumping water.
   d. Space cooling.

7. Conventional garbage possesses about ___ percent of the potential heat of coal.

8. Which of the following synthetic fuels can be most readily mixed with gasoline or used alone in automobile engines?

   a. Hydrogen.
   b. Hydrocarbons from algae.
   c. Methanol.

9. In limited locations, geothermal energy could be an important source of energy.

   a. True.
   b. False.

10. Because shale oil is plentiful, the cost of extraction and environmental factors are not concerns in using it as a source of energy.

    a. True.
    b. False.

EXERCISE:

1. List one advantage and one disadvantage for each of the following alternate energy sources.

Nuclear:
(A) _____
(D) _____

Hydropower:
(A) _____
(D) _____

Solar thermal:
(A) _____
(D) _____

Solid waste:
(A) _____
(D) _____

Solar electric:
(A) _____
(D) _____

Wind:
(A) _____
(D) _____

C. What Effect May the Energy Situation Have on an Individual?

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part One, Page 41)

STUDENT STUDY GUIDE OR TEST:

Circle letter representing correct answer, unless instructed otherwise.

1. It is estimated that energy prices will continue to increase by about:

   a. 5% per year.
   b. 10% per year.
   c. 15% per year.
   d. 20% per year.

2. What is the major reason why the U.S. economy is easily upset by the energy problem?

3. The U.S. Department of Energy is aiming for no more than a ___ percent increase in energy consumption per year.

4. List some trends expected in transportation and housing as a result of the increased energy costs:

   a. _____

   b. _____

   c. _____

   d. _____

III. Understanding the Use of Energy in Buildings

A. How is Energy Used in Buildings?

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part One, Pages 43-48)

STUDENT STUDY GUIDE OR TEST:

Circle letter representing correct answer, unless instructed otherwise.

1. By far the largest consumer of energy in buildings is:

   a. Lighting.
   b. Water heating.
   c. Air conditioning.
   d. Space heating.

2. The two major types of energy used in heating systems are:

   a. Wood.
   b. Gas and electricity.
   c. Electricity and oil.
   d. Oil and coal.

3. The most efficient type of lighting available is:

   a. Incandescent.
   b. Fluorescent.
   c. High intensity discharge.
   d. Natural gas.

4. A home clothes dryer uses how much more energy than a clothes washer? (Disregard energy for heating water).

   a. 2 times.
   b. 5 times.
   c. 10 times.
   d. 20 times.

5. How much more electricity does a frost-free refrigerator use than a standard one?

   a. Twice as much.
   b. Three times as much.
   c. Four times as much.
   d. Five times as much.

B. How Does Geographic Location Affect Energy Use in Buildings?

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part One, Pages 49-55)

STUDENT STUDY GUIDE OR TEST:

Circle letter representing correct answer, unless instructed otherwise.

1. Circle the four main climatic factors which influence energy use in buildings:

   a. Temperature.
   b. Moisture.
   c. Wind.
   d. Sun.
   e. Soil.

2. Space conditioning is controlling _____ at a comfortable level.

3. Which of the following is the most comfortable in regard to the temperature/moisture factor?

   a. Dry and cold.
   b. Damp and cold.
   c. Moist and hot.
   d. None of these.

4. Since the sun's path is precise and predictable, designers can use this information to help control the sun's effect on energy use in buildings.

   a. True.
   b. False.

C. How Design and Construction Methods Affect Energy Use

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part One, Pages 56-71)

STUDENT STUDY GUIDE OR TEST:

Circle letter representing correct answer, unless instructed otherwise.

1. Match each statement about site location and orientation with one of the four climatic zones.

   __a. Vegetation used for winter wind protection can also be used as shade in summer.
   __b. Orientation toward the east with afternoon shading.
   __c. Locate buildings on south or east slope for protection from prevailing winds.
   __d. Situate houses on south or north slopes with vegetation and shade.

   1. Cold zone.
   2. Temperate zone.
   3. Hot-humid zone.
   4. Hot-arid zone.

2. A rectangular building oriented north and south will generally use the least amount of energy.

   a. True.
   b. False.

3. Insulation works on the principle that trapped air is a poor heat conductor.

   a. True.
   b. False.

4. The primary source of aluminum foil on the inside surface of an insulating material functions as a:

   a. Wind barrier.
   b. Heat barrier.
   c. Moisture barrier.
   d. Energy barrier.

5. Buildings in some regions may require as much energy for cooling as for heating.

   a. True.
   b. False.

6. Without ventilation, attic temperatures may get as high as:

   a. 100°F.
   b. 120°F.
   c. 140°F.
   d. 160°F.

D. General Recommendations for Energy Efficiency in Residences

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part One, Page 72)

EXERCISE:

Complete the following:

1. Name five steps for improving the energy efficiency of your home.

   _____
   _____
   _____
   _____
   _____

2. From Table IX, list the R-values needed in your home for the following:

   _____ Ceilings
   _____ Walls
   _____ Floors

IV. Care and Maintenance of Energy Efficient Buildings

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part One, Pages 74-76)

STUDENT STUDY GUIDE OR TEST:

Circle letter representing correct answer, unless instructed otherwise.

1. Good maintenance is necessary for energy efficiency in buildings.

   a. True.
   b. False.

2. Things to check in the fall are:

   a. Insulation.
   b. Weatherstripping.
   c. Furnace filters.
   d. All of the above.

3. Window air conditioning units should be:

   a. Operated intermittently.
   b. Outside covered with a weatherproof covering.

4. Hot water tanks should be:

   a. Emptied.
   b. Partially drained.
   c. Painted.

5. Leaky faucets should be ignored.

   a. True.
   b. Flase.

6. Using electricity during off peak hours instead will help save energy.

   a. True.
   b. False.

7. In the spring and summer, attics should be:

   a. Well ventilated.
   b. Heated.
   c. Cooled.

8. In the spring and summer, windows should be:

   a. Exposed to the sun.
   b. Shaded.
   c. Closed.

9. Leave pilot light on furnaces:

   a. Year round.
   b. During heating season.
   c. During summer.

10. Dryer vents should be cleaned each season.

    a. True.
    b. False.

11. The energy efficiency of public buildings can be improved by:

    a. Cooperative groups.
    b. Good communication systems.
    c. Training programs.
    d. Assignment of responsibilities.
    e. All of the above.

12. An inspection and maintenance schedule is:

    a. Not important.
    b. Important.

13. Inspection and maintenance are best done by:

    a. Interested persons.
    b. Skilled persons.
    c. Anyone.

14. If you are not certain about installation and maintenance jobs:

    a. Go ahead by trial and error.
    b. Read the newspaper.
    c. Get expert advice.

15. Records of cost benefits are:

    a. Not important.
    b. Important.
    c. Submitted to the government.

16. Energy conservation is:

    a. The government's job.
    b. Everybody's job.
    c. The responsibility of the manufacturer.

EXERCISE:

Your teacher will provide homes and buildings for evaluation.

Make an inspection of the components that contribute to the use of energy and make recommendations for improvement. Follow suggestions in the manual.

Building Component	Suggestions for Improvement

V. Developing Energy Saving Habits

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part One, Pages 78-86)

STUDENT STUDY GUIDE OR TEST:

Circle letter representing correct answer, unless otherwise instructed.

1. With regard to energy, the nation must:

   a. Conserve energy.
   b. Develop alternate sources of energy.
   c. Slow down the acceleration in new demands for energy.
   d. All of the above.

2. The chief concern of the individual is:

   a. Developing alternate sources of energy.
   b. Conserving energy.
   c. Repair and maintenance.

3. To conserve energy in winter, set thermostat at:

   a. 68°F.
   b. 60°F.
   c. 68°F, day, and 69°F, night.

4. To conserve energy in summer, set thermostat at:

   a. 78°F.
   b. 72°F.
   c. 68°F.

5. Keep window drapes exposed to sun during winter:

   a. Drawn at night, open during the day.
   b. Open during the night, drawn during the day.
   c. Open all the time.

6. Window drapes exposed to sun during summer are:

   a. Open during the day.
   b. Drawn during the day.
   c. Closed all the time.

7. To conserve energy:

   a. Operate furnace at full capacity at all times.
   b. Heat 1/2 the building at a time.
   c. Heat only rooms that are being used.

8. When using a fireplace:

   a. Keep windows open.
   b. Keep damper closed.
   c. Provide outside air to fire box if possible.

9. Attic ventilators are used to:

   a. Supplement the air conditioning.
   b. Reduce the temperature in the attic.
   c. Provide for higher temperatures.

10. Air conditioner vents should be adjusted:

    a. Upward.
    b. Downward.

11. The heating system is aided by lighting.

    a. True.
    b. False.

12. Kitchen and bathroom vent fans should be operated:

    a. Continually.
    b. Intermittently.
    c. Only when needed.

13. Air conditioners should be operated:

    a. Continually.
    b. Intermittently.
    c. Only when needed.

14. The difference in energy use with the air conditioner set at 78°F instead of 72°F would be:

    a. 40%.
    b. 10%.
    c. 60%.

15. The most efficient lighting is:

    a. Incandescent.
    b. Fluorescent.
    c. Same.

16. Ways to save lighting energy are to:

    a. Use dimmer switches.
    b. Use lower watt bulbs.
    c. Turn lights off when not in use.
    d. All of the above.

17. Incandescent lights should be turned off:

    a. Each time you leave the room.
    b. If you are going to be gone for at least 15 minutes.

18. Fluorescent lights should be turned off:

    a. Each time you leave the room.
    b. If you are going to be gone for at least 15 minutes.

19. Refrigerator doors should be opened:

    a. All the way.
    b. As infrequently as possible.
    c. Remain closed.

20. Place hot dishes in the refrigerator:

    a. Immediately.
    b. Only after they have cooled.
    c. Gradually.

21. Use dishwasher:

    a. As often as you have dirty dishes.
    b. Only when you have a load.
    c. To wash glasses only.

22. When baking:

    a. Try to fill the oven.
    b. Cook one panful at a time.
    c. Leave the oven door cracked open for ventilation.

23. When boiling water:

    a. Leave the pot open.
    b. Keep a lid on the pot.
    c. Use a baking dish.

24. When cooking frozen foods:

    a. Allow them to thaw or partially thaw before cooking.
    b. Cook them immediately after removing from the freezer.
    c. Keep them in the original container.

25. Microwave ovens are:

a. Good for frying foods.
b. More efficient than infrared ovens.
c. Low in proteins.

26. Aluminum pots are the most efficient.

a. True.
b. False.

27. Aluminum foil is recommended to line:

a. The oven.
b. The reflector pans under electric burners.

28. When washing clothes:

a. Use hot water.
b. Use cold water.
c. Use salt water.

29. Dry clothes:

a. As rapidly as possible.
b. Only until dry.
c. Past the drying cycle to reduce wrinkles.

30. Energy can be saved:

a. At home.
b. In public buildings.
c. In office buildings.
d. In hospitals and schools.
e. All of the above.

31. Whose responsibility is it to save energy at school?

a. The teachers.
b. The students.
c. The building superintendent.
d. All of the above.

32. The same rules for conserving energy in the home generally apply to other buildings.

a. True.
b. False.

33. Energy surveys are:

a. Important.
b. A waste of time.
c. Expensive.

34. The best procedure for energy saving in buildings is to:

a. Assign responsibilities.
b. Let everyone decide what to do.
c. Turn the lights out when not in use.

35. The design and maintenance of public buildings are:

a. Important to energy saving.
b. Not important.
c. Always done with energy efficiency in mind.

36. A planned use of buildings can contribute to energy efficiency.

a. True.
b. False.

37. When providing food service in buildings:

a. It is best to cater foods.
b. Efficiency measures are similar to those for the home.
c. Cook only one meal per day.

EXERCISE: Developing Energy Saving Habits

Have students take a personal inventory of their energy saving habits and activities. Check the techniques practiced at home, at school and in other public buildings.

See lists in the manual.

Energy Saving Practices	Personal Participation	
	Yes	No
1. Clean heating systems.	___	___
2. Adjust thermostats.	___	___
3. Use electric blanket.	___	___
4. Close and open drapes as needed.	___	___
5. Use fireplaces sparingly.	___	___
6. Keep heating and cooling vents clear.	___	___
7. Use a ceiling fan instead of air conditioning on cool nights.	___	___
8. Adjust air conditioner vents upward.	___	___
9. Adjust heating vents downward.	___	___
10. Avoid unnecessary lighting.	___	___
11. Open windows and doors sparingly.	___	___
12. Use kitchen and bathroom vents only when needed.	___	___
13. Use fluorescent lights when possible.	___	___
14. Use dimmer switches when available.	___	___
15. Never stand and hold refrigerator door open.	___	___
16. Keep refrigerator defrosted.	___	___
17. Keep dishes covered in refrigerator.	___	___
18. Never put hot dishes in refrigerator.	___	___
19. Don't stay in shower too long.	___	___
20. Wash only full load of dishes in dishwasher.	___	___
21. Bake as many items as possible in one oven at a time.	___	___
22. Cook thawed or partially thawed food.	___	___
23. Use a microwave oven.	___	___
24. Use copper or stainless steel cooking utensils.	___	___
25. Use a pressure cooker when possible.	___	___
26. Turn off oven 5 minutes ahead of time.	___	___
27. Wash full loads of clothes.	___	___
28. Wash clothes in cold water.	___	___
29. Never overdry clothes.	___	___
30. Keep the lint filter clean on dryers.	___	___
31. When away from home, I am conscious of energy saving just as much as when I am at home.	___	___
32. Participate in energy efficiency activities.	___	___

Energy Saving Practices	Personal Participation	
	Yes	No
33. Read and try to keep up with energy saving techniques.	___	___
34. Try to encourage others to become energy conscious.	___	___
35. Make energy surveys.	___	___
36. Present them to persons in authority.	___	___
37. See that lights are turned off when not in use in accordance with the building plan.	___	___
38. See that thermostats are turned down or up when not in use in accordance with the building plan.	___	___
39. Seek to learn the energy efficiency plan for the building you are in and adhere to it.	___	___

Part Two:
DETERMINING AMOUNT OF ENERGY LOST OR GAINED AND CALCULATING COST BENEFITS

I. Determining Amount of Energy Lost or Gained in a Building

A. Terms Used to Measure Energy in Buildings

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part Two, Pages 11-16)

STUDENT STUDY GUIDE OR TEST:

1. Match terms to definitions:

   a. Btu.
   b. Btu/hr.
   c. Heat flow by conduction.
   d. Heat flow by infiltration.
   e. Heat flow by radiation.

   1. __Rate of heat flow.
   2. __Heat flow by solar energy.
   3. __Unit of heat.
   4. __Heat flow through solids.
   5. __Heat loss through air exchange.

2. Match terms to definitions:

   a. Thermal conductivity (k-value).
   b. Thermal conductance (C-value).
   c. Coefficient of heat transfer (U-value).
   d. Thermal resistance (R-value).

   1. __Heat transferred through a material 1 sq. ft., any thickness.
   2. __Heat transferred through a material 1 sq. ft., 1 ft. thick.
   3. __Resistance to heat flow.
   4. __Heat transferred through a wall section.

3. Match terms to definitions:

   a. Infiltration.
   b. Ventilation.
   c. Fenestration.
   d. Kilowatt-hour.
   e. Inside design temperature.
   f. Outside design temperature.
   g. Heating degree day.
   h. Cooling degree day.
   i. Discomfort index.
   j. Relative humidity.
   k. Comfort zone.

   1. __Introduction of outside air
   2. __$0.55\ T_d + 0.2\ T_{dp} + 17.5$
   3. __Amount of moisture in the air as compared to its capacity.
   4. __Average extreme temperature in a locality.
   5. __Average outside degree below 65°F.
   6. __3,413 Btu.
   7. __Between 72°F and 80°F and 20% and 60% RH.
   8. __Windows.
   9. __Average outside degree above 75°F.
   10. __Winter, 72°F; Summer, 78°F.
   11. __Movement of air in and out of a building.

B. Understanding Heat Losses and Gains in Buildings

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part Two, Pages 17-23)

STUDENT STUDY GUIDE OR TEST:

1. Match the formulas:

   a. Heat flow by conduction through a solid (qc).
   b. Heat flow by conductance through a wall (qc).
   c. Thermal resistivity (r).

   __ $Ca(t_2-t_1)$

   __ $\frac{kA}{L}(t_2-t_1)$

   __ $\frac{1}{K}$

2. The formula for heat flow by conduction (qc) through a composite wall is:

   a. $\frac{1}{R_t}(t_2-t_1)$

   b. $R_1 + R_2$

3. The formula for heat flow by conduction (qc) using coefficient of heat transfer (U-value) is:

   a. $UA\ (t_1-t_2)$
   b. $R_1 + R_2$

4. Example: Given an 8 x 10-ft wall composed of wood siding, sheathing, gypsum board and no insulation. Find the heat loss by conduction (qc).

   Outside temperature (t_o) 20°F.
   Inside temperature (t_i) 68°F.

   Use R-values given on page in manual.

   qc = UA (t)
   qc =

5. Example: Given a 20 x 25-ft room with exterior doors or windows on one side, heat loss by infiltration (qi). Outside temperature (t_o) = 20°F. Inside temperature (t_i) = 68°F. Find heat loss by infiltration. See Table VI, page 43, in manual.

   $qi = (.018)(Qi)t_o-t_i)$

   qi =

6. Heat losses and gains are also affected by:

   a. Ventilation.
   b. Radiation.
   c. Both of the above.

C. Estimating Heat Loads in Buildings

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part Two, Pages 25-34)

STUDENT STUDY GUIDE OR TEST:

PROBLEM NO. 1:

1. Estimate the heat loss from the house in Example Problem No. 6 in manual if it is located in Atlanta, Georgia.

Solution:

(a) Make changes on Worksheet A and recompute total Btu/hr.

(b) Note: The only difference between this problem and Problem No. 6 is the outdoor design temperature.

Outside design temperature = 20°F.

Thus, the temperature difference = 65 - 20 = 45°F.

PROBLEM NO. 2:

Repeat Example Problem No. 6 in the manual for an inside design temperature of 75°F.

Solution:

(a) Make changes on Worksheet B and recompute total Btu/hr.

(b) Note: The only difference between this problem and Problem No. 6 in the manual is the temperature difference:

t = 75 - 14 = 61°F.

PROBLEM NO. 3:

Repeat Problem No. 6 in the manual if the fiberglass insulation is replaced by 1 inch polystyrene in the walls and 2 inches of polystyrene in the ceiling. Assume polystyrene extruded with density of 2.2 lb/ft^3.

(a) The heat transmission coefficients for the walls and ceilings change to:

Thermal resistance of polystyrene - 5.0/inch.

Walls:

Construction	R Between Framing	R In Framing
1. Outside surface	0.17	0.17
2. Wood siding	0.81	0.81
3. Sheathing	1.32	1.32
4. 1" insulation	5.00	—
5. Studs	—	4.38
6. Air space	1.01	—
7. Gypsum wallboard	0.45	0.45
8. Inside surface	0.68	0.68
	9.44	7.81

$\nu_{in} = 1/9.44 = 0.106$

$\nu_{stud} = 1/7.81 = 0.128$

$\nu_{avg} = 0.2\ (.128) + .8\ (.106) = 0.110$

Ceiling-Roof:

Without insulation and non-reflective air space, U = 0.206

R-value for 2" insulation = 10

From Table XX

v_{in} ceiling = 0.07

(b) Make necessary changes on Worksheet C and recompute total Btu/hr.

WORKSHEET A. HEAT FLOW CALCULATIONS

Problem No. 1 in Workbook

Overall Heat Transfer Coefficients (U)
Exterior Walls 0.081 Btu/hr-ft^2-°F
Ceiling-Roof Combo 0.04 Btu/hr-ft^2-°F
Floors ___ Btu/hr-ft^2-°F
Slabs 50 Btu/hr-ft
Windows 0.58 Btu/hr-ft^2-°F
Doors 0.49 Btu/hr-ft^2-°F

Design Temperatures
Inside temp (t_i) 65°F
Outside temp (t_o) 20°F

Room	Building Component	Transmission Coefficient (U)	Surface Area (A)	Temp. Difference ($t_i - t_o$)	Conduction Losses $q_c = UA(\ t)$	Air Exchange	Infiltration Rate (Q_i)	Infiltration Losses $q_i = .018Q_i(\ t)$
1	Ext. walls	.081	330	51	1363			
	Ceiling-roof	.04	225	51	459			
	Floor	-	-	-	-			
	Slab	50*	45*	-	2250*			
	Windows	0.58	30	51	887			
	Doors	0.49	0	51	0			
	TOTAL ROOM LOSS				4959	1.5	1800	1652
2	Ext. walls	.081	260	51	1074			
	Ceiling-roof	.04	300	51	612			
	Floor	-	-	-	-			
	Slab	50*	35*	-	1750*			
	Windows	.58	0	51	0			
	Doors	.49	20	51	500			
	TOTAL ROOM LOSS				3936	1.0	1600	1468
3	Ext. walls	.081	495	51	2045			
	Ceiling-roof	.04	500	51	1020			
	Floor	-	-	-	-			
	Slab	50*	70*	-	3500*			
	Windows	.58	45	51	1330			
	Doors	.49	20	51	500			
	TOTAL ROOM LOSS				8395	2.0	5360	4920

*Slab Load = Factor from Table XI x Exposed Perimeter Length
Total Conduction Loss = 4959 + 3936 + 8395 = 17,290 Btu/hr

Total Infiltration Loss = 1652 + 1648 + 4920 = 8,040 Btu/hr
Total Heat Loss = 17,290 + 8,040 = 25,330 Btu/hr

WORKSHEET B. HEAT FLOW CALCULATIONS

Problem No. 2 in Workbook

Overall Heat Transfer Coefficients (U)
Exterior Walls 0.081 Btu/hr-ft2-°F
Ceiling-Roof Combo 0.04 Btu/hr-ft2-°F
Floors Btu/hr-ft2-°F
Slabs 50 Btu/hr-ft
Windows 0.58 Btu/hr-ft2-°F
Doors 0.49 Btu/hr-ft2-°F

Design Temperatures
Inside temperature (t_i) 75°F
Outside temperature (t_o) 14°F

Room	Building Component	Transmission Coefficient (U)	Surface Area (A)	Temp. Difference ($t_i - t_o$)	Conduction Losses $q_c = UA(\ t)$	Air Exchange	Infiltration Rate (Q_i)	Infiltration Losses $q_i = .018Q_i(\ t)$
1	Ext. walls	.081	330	51	1363			
	Ceiling-roof	.04	225	51	459			
	Floor	-	-	-	-			
	Slab	50*	45*	-	2250*			
	Windows	0.58	30	51	887			
	Doors	0.49	0	51	0			
	TOTAL ROOM LOSS				4959	1.5	1800	1652
2	Ext. walls	.081	260	51	1074			
	Ceiling-roof	.04	300	51	612			
	Floor	-	-	-	-			
	Slab	50*	35*	-	1750*			
	Windows	.58	0	51	0			
	Doors	.49	20	51	500			
	TOTAL ROOM LOSS				3936	1.0	1600	1468
3	Ext. walls	.081	495	51	2045			
	Ceiling-roof	.04	500	51	1020			
	Floor	-	-	-	-			
	Slab	50*	70*	-	3500*			
	Windows	.58	45	51	1330			
	Doors	.49	20	51	500			
	TOTAL ROOM LOSS				8395	2.0	5360	4920

*Slab Loss = Factor from Table XI x Exposed Perimeter Length
Total Conduction Loss = 4959 + 3936 + 8395 = 17,290 Btu/hr
Total Infiltration Loss = 1652 + 1468 + 4920 = 8,040 Btu/hr
Total Heat Loss = 17,290 + 8,040 = 25,330 Btu/hr

WORKSHEET C. HEAT FLOW CALCULATIONS

Problem No. 3 in Workbook

Overall Heat Transfer Coefficients (U)
Exterior Walls 0.110 Btu/hr-ft^2-°F
Ceiling-Roof Combo 0.07 Btu/hr-ft^2-°F
Floors ____ Btu/hr-ft^2-°F
Slabs 50 Btu/hr-ft
Windows 0.58 Btu/hr-ft^2-°F
Doors 0.49 Btu/hr-ft^2-°F

Design Temperatures
Inside temp (t_i) 65°F
Outside temp (t_o) 14°F

Room	Building Component	Transmission Coefficient (U)	Surface Area (A)	Temp. Difference ($t_i - t_o$)	Conduction Losses q_c = UA(Δt)	Air Exchange	Infiltration Rate (Q_i)	Infiltration Losses $q_i = .018Q_i$ (Δt)
1	Ext. walls	.081	330	51	1363			
	Ceiling-roof	.04	225	51	459			
	Floor	-	-	-	-			
	Slab	50*	45*	-	2250*			
	Windows	0.58	30	51	887			
	Doors	0.49	0	51	0			
	TOTAL ROOM LOSS				4959	1.5	1800	1652
2	Ext. walls	.081	260	51	1074			
	Ceiling-roof	.04	300	51	612			
	Floor	-	-	-	-			
	Slab	50*	35*	-	1750*			
	Windows	.58	0	51	0			
	Doors	.49	20	51	500			
	TOTAL ROOM LOSS				3936	1.0	1600	1468
3	Ext. walls	.081	495	51	2045			
	Ceiling-roof	.04	500	51	1020			
	Floor	-	-	-	-			
	Slab	50*	70*	-	3500*			
	Windows	.58	45	51	1330			
	Doors	.49	20	51	500			
	TOTAL ROOM LOSS				8395	2.0	5360	4920

*Slab Loss = Factor from Table XI x Exposed Perimeter Length
Total Conduction Loss = 4959 + 3936 + 8395 = 17,290 Btu/hr
Total Infiltration Loss = 1652 + 1468 + 4920 = 8,040 Btu/hr
Total Heat Loss = 17,290 + 8,040 = 25,330 Btu/hr

PROBLEM NO. 4:

Your teacher will provide building plans. Estimate heating loads for your location and compare energy saving practices. Follow procedures given in manual beginning on page 25. Use Worksheet D provided.

Solution:

1. Determine R-values and U-values for the building components.

	R-Value	U-Value
Walls	_____	_____
Ceilings	_____	_____
Floors	_____	_____
Windows	_____	_____
Doors	_____	_____

2. Determine areas of building components.

Exterior walls	_____ ft^2
Ceiling	_____ ft^2
Windows	_____ ft^2
Doors	_____ ft^2
Floor	_____ ft^2

3. Determine design temperatures and temperature difference from outside and inside.

t_i	_____ °F
t_o	_____ °F
t	_____ °F

4. Calculate heat flow by conduction (qc).

Walls	_____ Btu/hr
Ceilings	_____ Btu/hr
Floor	_____ Btu/hr
Windows	_____ Btu/hr
Doors	_____ Btu/hr
Total	_____ Btu/hr

5. Calculate heat flow by infiltration (qi).

Air exchange in each room	_____ ft^3/hr
qi each room	_____ Btu/hr
qi total	_____ Btu/hr

6. Calculate total heat flow from building.

qc	_____ Btu/hr
qi	_____ Btu/hr
Total	_____ Btu/hr

7. Estimate seasonal heating load (q_s). Follow procedures in manual.

- Estimate seasonal heat loss.

$$q_s = \frac{q \times D \times 24}{t}$$

q_s = _____ Btu/season.

- Estimate quantity of fuel required per season.

$$E = q_s \left[\frac{C_D \times C_F}{7 \times V}\right]$$

E = _____ cu. ft. gas

E = _____ gal. fuel oil

E = _____ kwh

8. Compare energy saving practices.

Find difference in seasonal heat load without energy efficiency practices and with certain energy efficiency practices.

- Estimate load without	_____ Btu/season
- Estimate load with	_____ Btu/season
- Compare fuel required:	
- without	_____ kwh/season
- with	_____ kwh/season

WORKSHEET D. HEAT FLOW CALCULATIONS

Problem No. 4 in Workbook

Overall Heat Transfer Coefficients (U)
Exterior Walls ____ Btu/hr-ft^2-°F
Ceiling-roof combo ____ Btu/hr-ft^2-°F
Floors ____ Btu/hr-ft^2-°F
Slabs ____ Btu/hr-ft
Windows ____ Btu/hr-ft^2-°F
Doors ____ Btu/hr-ft^2-°F

Design Temperatures
Inside temp ____ °F
Outside temp ____ °F

Room	Building Component	Transmission Coefficient (U)	Surface Area (A)	Temp Difference ($t_i - t_o$)	Conduction Losses $q_c = UA(\ t)$	Air Exchange	Infiltration Rate (Q_i)	Infiltration Losses $q_i = .018Q_i(\ t)$
1	Ext. walls							
	Ceiling-roof							
	Floor							
	Slab							
	Windows							
	Doors							
	TOTAL ROOM LOSS							
2	Ext. walls							
	Ceiling-roof							
	Floor							
	Slab							
	Windows							
	Doors							
	TOTAL ROOM LOSS							
3	Ext. walls							
	Ceiling-roof							
	Floor							
	Slab							
	Windows							
	Doors							
	TOTAL ROOM LOSS							

Total Conduction Loss _____
Total Infiltration Loss _____
Total Heat Loss _____

E. Estimating Cooling Loads in Buildings

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part Two, Pages 35-44).

PROBLEM NO. 1:

Estimate cooling load for the house in Example Problem No. 8 if the house is located in Little Rock, Arkansas.

Solution:

(a) Outside design temperature, mean daily range, and infiltration factor change to:

Outside temperature = 96°F.
Mean daily range = 22°F.
Infiltration factor = 1.5

(b) The effective design temperature (EID's) now change.

(c) Make changes in Worksheet A as needed and recompute total Btu/hr.

PROBLEM NO. 2:

Repeat Example Problem No. 8 if fiberglass insulation is replaced with 1 inch extruded polystyrene (R = 5.0/inch) in the walls and 2 inches extruded polystyrene (R = 5.0/inch) in the ceiling.

Solution:

(a) The heat transmission coefficients for the walls and ceilings change to:

Thermal resistance of polystyrene = 5.0/inch.

Walls:

Construction	R Between Framing	R At Framing
1. Outside surface	0.17	0.17
2. Wood siding	0.81	0.81
3. Sheathing	1.32	1.32
4. 1" insulation	5.00	—
5. Studs	—	4.38
6. Air space	1.01	—
7. Gypsum wallboard	0.45	0.45
8. Inside surface	0.68	0.68
	9.44	7.81

$v_{in} = 1/9.44 = 0.106$
$v_{stud} = 1/7.81 = 0.128$
v_{Avg}: .2 (.128) + .8 (.106) = 0.110

Ceiling-Roof:

Without insulation and non-reflective air space, = 0.206.

R-value for 2" insulation = 10.

From Table IX:

v_{in} ceiling = 0.07

(b) Make changes in Worksheet B. Cooling Loads and recompute total Btu/hr.

WORKSHEET A. COOLING LOADS

Form for Problem No. 1 in Workbook

Overall Heat Transmission Coefficients (U)
Exterior Walls 0.081 Btu/hr-ft^2-°F
Ceiling-Roof Combo 0.04 Btu/hr-ft^2-°F
Floors ____ Btu/hr-ft^2-°F
Slabs 50 Btu/hr-ft2
Windows 0.58 Btu/hr-ft^2-°F
Doors 0.49 Btu/hr-ft^2-°F

Design Temperatures
Inside Temperature 75°F
Outside Temperature 90°F
Mean Daily Range 21°F

Room	Building Component	Heat Transmission Coefficient (U)	Area	ETD	Conduction Sensible Cooling Load (Btu/hr)	Infiltration Factor	Gross Exposed Wall Area	Infiltration Sensible Cooling Load (Btu/hr)	Occupancy Cooling Load (Btu/hr)	Total Sensible Cooling Load (Btu/hr)	Total Cooling Load (Btu/hr)
	Ext. walls	0.081	330	18.6	497						
	Ceiling-roof	0.040	225	31.0	279						
	Floor	-	-	-	-						
	Slab		225	0	0						
1	Doors	0.49	0	18.6	0						
	Window (N)	0.58	15	17.0	148						
	Window (W)	0.58	15	56.0	487						
	Window ( )	-	-	-	-						
	Window ( )	-	-	-	-						
	TOTAL				1411	1.1	360	396	1650	3457	4494
	Ext. walls	0.081	260	18.6	392						
	Ceiling-roof	0.040	300	31.0	372						
	Floor	-	-	-	-						
	Slab	-	225	0	0						
2	Doors	0.49	20	18.6	182						
	Window ( )	-	-	-	-						
	Window ( )	-	-	-	-						
	Window ( )	-	-	-	-						
	Window ( )	-	-	-	-						
	TOTAL				946	1.1	280	308	0	1254	1630
	Ext. walls	0.081	495	18.6	746						
	Ceiling-roof	0.040	500	31.0	620						
	Floor	-	-	-	-						
	Slab	-	-	-	0						
3	Doors	0.49	20	18.6	182						
	Window (N)	0.58	30	17.0	296						
	Window (E)	0.58	15	56.0	487						
	Window ( )	-	-	-	-						
	Window ( )	-	-	-	-						
	TOTAL				2331	1.1	560	616	0	2947	3831

TOTAL COOLING LOAD = 4494 + 1630 + 3831 = 9,955 Btu/hr

WORKSHEET B. COOLING LOADS

Form for Problem No. 2 in Workbook

Overall Heat Transmission Coefficients (U)
Exterior Walls 0.081 Btu/hr-ft^2-°F
Ceiling-Roof Combo 0.04 Btu/hr-ft^2-°F
Floors ____ Btu/hr-ft^2-°F
Slabs 50 Btu/hr-ft^2
Windows 0.58 Btu/hr-ft^2-°F
Doors 0.49 Btu/hr-ft^2-°F

Design Temperatures
Inside Temperature 75°F
Outside Temperature 90°F
Mean Daily Range 21°F

Room	Building Component	Heat Transmission Coefficient (U)	Area	ETD	Conduction Sensible Cooling Load (Btu/hr)	Infiltration Factor	Gross Exposed Wall Area	Infiltration Sensible Cooling Load (Btu/hr)	Occupancy Cooling Load (Btu/hr)	Total Sensible Cooling Load (Btu/hr)	Total Cooling Load (Btu/hr)
	Ext. walls	0.081	330	18.6	497						
	Ceiling-roof	0.040	225	31.0	279						
	Floor	-	-	-	-						
	Slab		225	0	0						
1	Doors	0.49	0	18.6	0						
	Window (N)	0.58	15	17.0	148						
	Window (W)	0.58	15	56.0	487						
	Window ( )	-	-	-	-						
	Window ( )	-	-	-	-						
	TOTAL				1411	1.1	360	396	1650	3457	4494
	Ext. walls	0.081	260	18.6	392						
	Ceiling-roof	0.040	300	31.0	372						
	Floor	-	-	-	-						
	Slab	-	225	0	0						
2	Doors	0.49	20	18.6	182						
	Window ( )	-	-	-	-						
	Window ( )	-	-	-	-						
	Window ( )	-	-	-	-						
	Window ( )	-	-	-	-						
	TOTAL				946	1.1	280	308	0	1254	1630
	Ext. walls	0.081	495	18.6	746						
	Ceiling-roof	0.040	500	31.0	620						
	Floor	-	-	-	-						
	Slab	-	-	-	0						
3	Doors	0.49	20	18.6	182						
	Window (N)	0.58	30	17.0	296						
	Window (E)	0.58	15	56.0	487						
	Window ( )	-	-	-	-						
	Window ( )	-	-	-	-						
	TOTAL				2331	1.1	560	616	0	2947	3831

TOTAL COOLING LOAD = 4494 + 1630 + 3831 = 9,955 Btu/hr

PROBLEM NO. 3:

Your teacher will provide a building plan. Estimate cooling loads for your location and compare energy-saving practices. Follow procedures given in manual beginning on page 25. Use Worksheet C provided.

Solution:

1. Determine cooling load due to heat gain through walls, floors, roofs, and ceilings.

Walls	_____ Btu/hr
Floor	_____ Btu/hr
Roof	_____ Btu/hr
Ceiling	_____ Btu/hr
Windows	_____ Btu/hr
Doors	_____ Btu/hr
Infiltration	_____ Btu/hr
Ventilation	_____ Btu/hr
Occupancy	_____ Btu/hr
Latent	_____ Btu/hr
Total	_____ Btu/hr

2. Determine R-values and U-values for building components.

	R-Value	U-Value
Walls	_____	_____
Ceiling	_____	_____
Floor	_____	_____
Windows	_____	_____
Doors	_____	_____

3. Determine area of building components.

Exterior walls	_____ ft^2
Ceiling	_____ ft^2
Windows	_____ ft^2
Doors	_____ ft^2
Floor	_____ ft^2

4. Determine design temperature and mean daily range.

Design temperature:

t_i	_____ °F
t_o	_____ °F
Δt	_____ °F

Mean daily range: _____ °F

5. Find equivalent temperature difference (ETD).

Walls	_____ °F
Doors	_____ °F
Ceilings	_____ °F
Floors	_____ °F
Windows	
North	_____ °F
East	_____ °F
West	_____ °F
South	_____ °F

6. Calculate conduction sensible cooling loads. $q = UA\ (ETD)$.

Exterior walls	_____ Btu/hr
Ceiling	_____ Btu/hr
Floor	_____ Btu/hr
Roof	_____ Btu/hr
Door	_____ Btu/hr
Windows	_____ Btu/hr
Total	_____ Btu/hr

7. Calculate occupancy loads.

_____ Btu/hr

8. Calculate infiltration loads.

_____ Btu/hr

9. Calculate total sensible load.

_____ Btu/hr

10. Calculate total cooling load.

_____ Btu/hr

11. Estimate seasonal cooling load.

$$q_{sc} = \frac{q \times D_c \times 24}{\Delta t}$$

Evaluate design cooling load

_____Btu/hr

Estimate equivalent full-load hours for building location

_____Btu/hr

Seasonal cooling load

_____Btu/season

12. Estimate quantity of energy needed per season.

$$\frac{\text{Seasonal cooling load}}{3413 \text{ Btu/kwh}} = \text{_____kwh/season}$$

13. Compare energy saving practices.

Find difference in seasonal cooling load without energy efficient practices and with certain energy efficient practices.

- Estimate load without _____Btu/season
- Estimate load with _____Btu/season
- Compare energy required
  - without _____kwh/season
  - with _____kwh/season

WORKSHEET C. COOLING LOADS

Form for Problem No. 3 in Workbook

Overall Heat Transmission Coefficients (U)

Exterior Walls _____ Btu/hr-ft^2-°F
Ceiling-Roof Combo _____ Btu/hr-ft^2-°F
Floors ___ Btu/hr-ft^2-°F
Slabs ___ Btu/hr-ft^2-°F
Windows ___ Btu/hr-ft^2-°F
Doors ___ Btu/hr-ft^2-°F

Design Temperatures

Inside Temperature
Outside Temperature
Mean Daily Range

Room	Building Component	Heat Transmission Coefficient (U)	Area	ETD	Conduction Sensible Cooling Load (Btu/hr)	Infiltration Factor	Gross Exposed Wall Area	Infiltration Sensible Cooling Load (Btu/hr)	Occupancy Cooling Load (Btu/hr)	Total Sensible Cooling Load (Btu/hr)	Total Cooling Load (Btu/hr)
	Ext. walls										
	Ceiling-roof										
	Floor										
	Slab										
1	Doors										
	Window (N)										
	Window (W)										
	Window ( )										
	Window ( )										
	TOTAL										
	Ext. walls										
	Ceiling-roof										
	Floor										
	Slab										
2	Doors										
	Window ( )										
	Window ( )										
	Window ( )										
	Window ( )										
	TOTAL										
	Ext. walls										
	Ceiling-roof										
	Floor										
	Slab										
3	Doors										
	Window (N)										
	Window (E)										
	Window ( )										
	Window ( )										
	TOTAL										

COOLING LOAD =

F. Determining Cost Benefits of Using Energy-Saving Practices

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part Two, Pages 45-49)

STUDENT STUDY GUIDE OR TEST:

Circle the letter(s) that represent the correct answer(s), unless instructed otherwise.

1. The benefit/cost ratio should be:

   a. 0.
   b. More than 1.
   c. Less than 1.

2. The benefit/cost ratio does what as expected life increases?

   a. Increases.
   b. Decreases.

3. The benefit/cost ratio does what as interest rates increase?

   a. Increases.
   b. Decreases.

4. The "payback period" and "time to recoup investment" are considered to be:

   a. The same.
   b. Different.

PROBLEM NO. 1: Calculating the Benefit/Cost Ratio

If you estimate a net annual savings of $500 and the first cost of retro-fitting is $1,000, find the benefit cost ratio. Assume a 15 year life at an annual increase in cost of 10%.

PROBLEM NO. 2: Calculating the Payback Period

From the previous example, calculate the payback period.

PROBLEM NO. 3: Calculating the Time to Recoup Investment

From PROBLEM NO. 1, calculate the time to recoup investment. See Table XXI.

Part Three:
SELECTING AND INSTALLING ENERGY EFFICIENT MATERIALS AND EQUIPMENT

I. Determining Which Measures Are the Most Efficient and Economical

A. What Site to Choose

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part Three, Pages 11-14)

STUDENT STUDY GUIDE OR TEST:

Circle the letter(s) that represent the correct answer(s), unless instructed otherwise.

1. Factors influencing site location for energy efficiency include:

   a. Sunshine.
   b. Wind.
   c. Rain.
   d. Temperature.
   e. Humidity.
   f. All of the above.

2. Climate is a major factor in energy requirements for buildings.

   a. True.
   b. False.

3. Match the following climatic zones in the U.S.:

   a. Cool.
   b. Temperate.
   c. Hot-arid.
   d. Hot-humid.

   1. __Southeast.
   2. __North Central.
   3. __Middle.
   4. __Southwest.

4. In Figure 1, pages 42 and 43, indicate the climatic zone recommended for each building orientation for energy efficiency.

   a. Cool.
   b. Temperate.
   c. Hot-humid.
   d. Hot-arid.

   __1
   __2
   __3
   __4
   __5
   __6
   __7
   __8

5. Match the following advantages as to site location.

   a. Sunshine.
   b. Shade.
   c. Prevailing winds.

   1. __Cold.
   2. __Hot.
   3. __Humid.

6. Places to get help and advice on energy saving techniques are:

   a. Energy Extension Office.
   b. Cooperative Extension Service.
   c. Colleges of Engineering and Technology.
   d. Private architects.
   e. Utility companies.
   f. All of the above.

EXERCISE:

Select a desirable site for contructing a building and explain the reasons why.

B. What Design to Use

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part Three, Pages 14-23)

STUDENT STUDY GUIDE OR TEST:

Circle the letter(s) that represent the correct answer(s), unless instructed otherwise.

1. An energy efficient home or building is one that is designed to provide space and comfort to its occupants at reasonable cost and without harmful effects on the environment.

   a. True.
   b. False.

2. The shape of a building has no influence on the energy requirements.

   a. True.
   b. False.

3. Which three factors influence the shape of a building with regard to energy use?

   a. Volume to surface ratio.
   b. Solar exposure.
   c. Potential for insulation.
   d. Size of family.

4. In Figure 2, page 44, match the description of the foundations to the illustrations as numbered:

   a. Isolated piers.
   b. Continuous footing.
   c. Slab.

   __1
   __2
   __3

5. Flat roofs may be used for:

   a. Retaining rain water and/or snow for insulation.
   b. Shedding snow in winter.
   c. Attic storage.

6. Pitched roofs provide for attics which need no insulation.

   a. True.
   b. False.

7. Roof overhang should provide for:

   a. Window shading in summer.
   b. Window shading in winter.
   c. Shedding snow.

8. Walls should be designed to:

   a. Reduce heat transfer.
   b. Provide a vapor barrier.
   c. Protect the interior from the weather.
   d. All of the above.

9. Heat transfer through windows is:

   a. Less than through walls.
   b. Greater than through walls.

10. Match the following recommendations for window size and locations:

    a. Large.
    b. Small.
    c. Medium.
    d. None.

    __East.
    __West.
    __North.
    __South.

11. When practical, doors should be placed on the:

    a. South.
    b. East.
    c. North.

12. The comfort range in temperature when designing buildings is:

    a. 40°F-90°F.
    b. 60°F-85°F.
    c. 80°F-90°F.

13. Humidity affects energy requirements for comfort. More heat is required when the air is:

    a. Hot and humid.
    b. Cool and humid.
    c. Cool and dry.

14. Space design for energy efficiency requires:

    a. Smaller heated and cooled areas.
    b. Larger heated and cooled areas.
    c. Space is not important.

15. Building design for energy efficiency is:

    a. Relatively important.
    b. Very important.
    c. Not important.

16. Initial cost of energy efficient structures and compared to conventional design is:

    a. Much higher.
    b. Very little higher.
    c. About the same.

EXERCISE:

Draw a sketch of an energy efficient building and point out reasons.

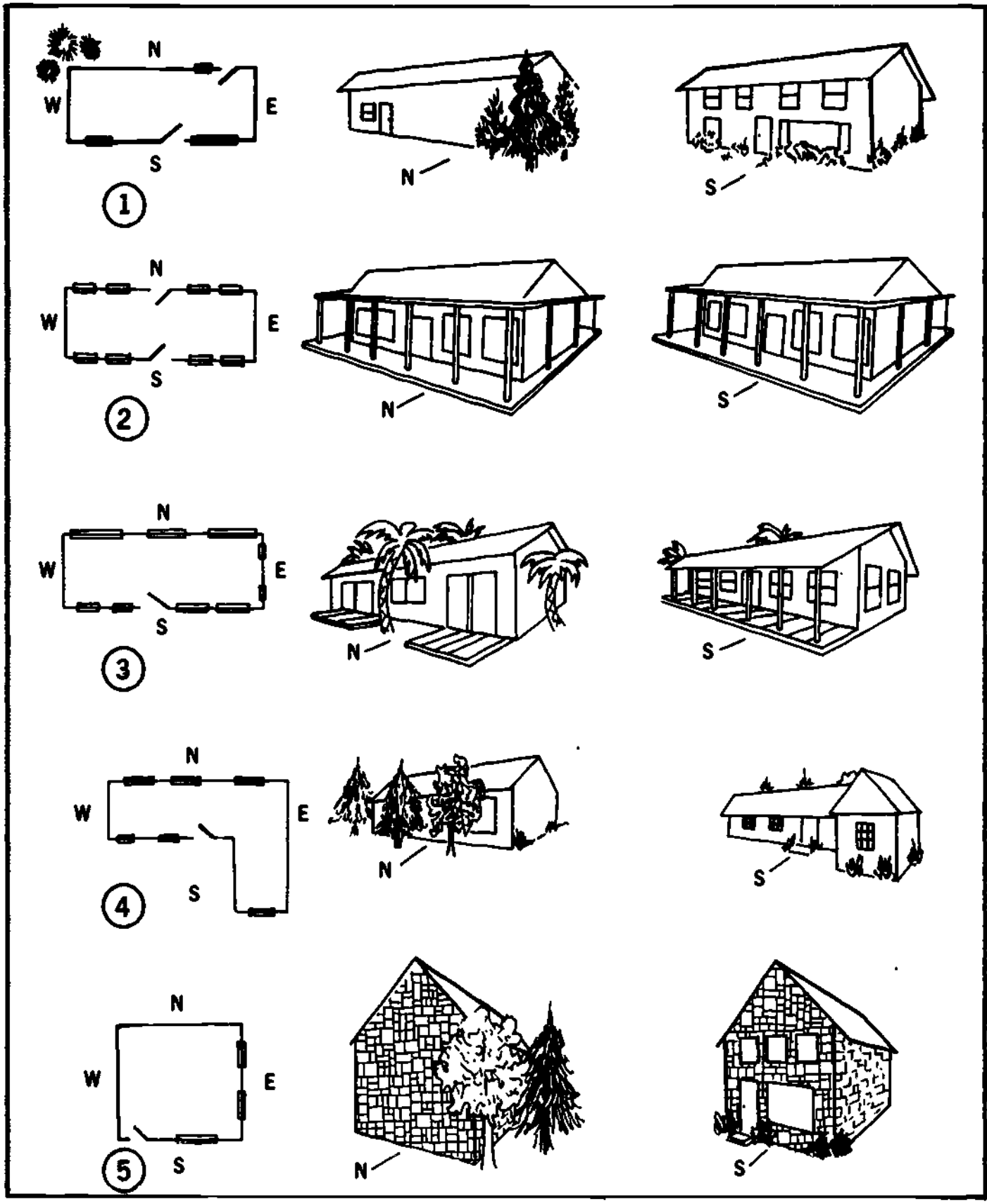


FIGURE 1. (Continued on next page)

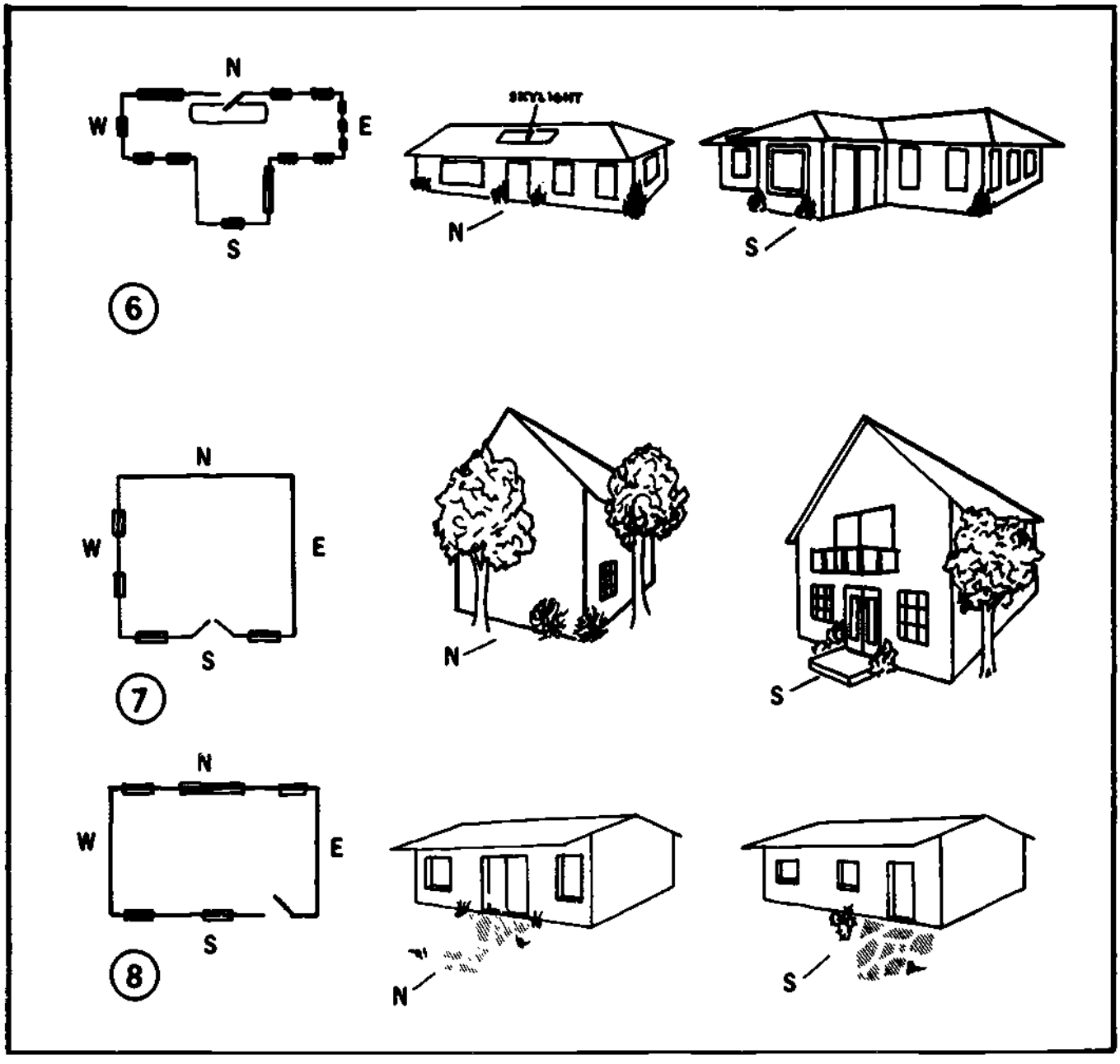


FIGURE 1. (Continued from preceding page)

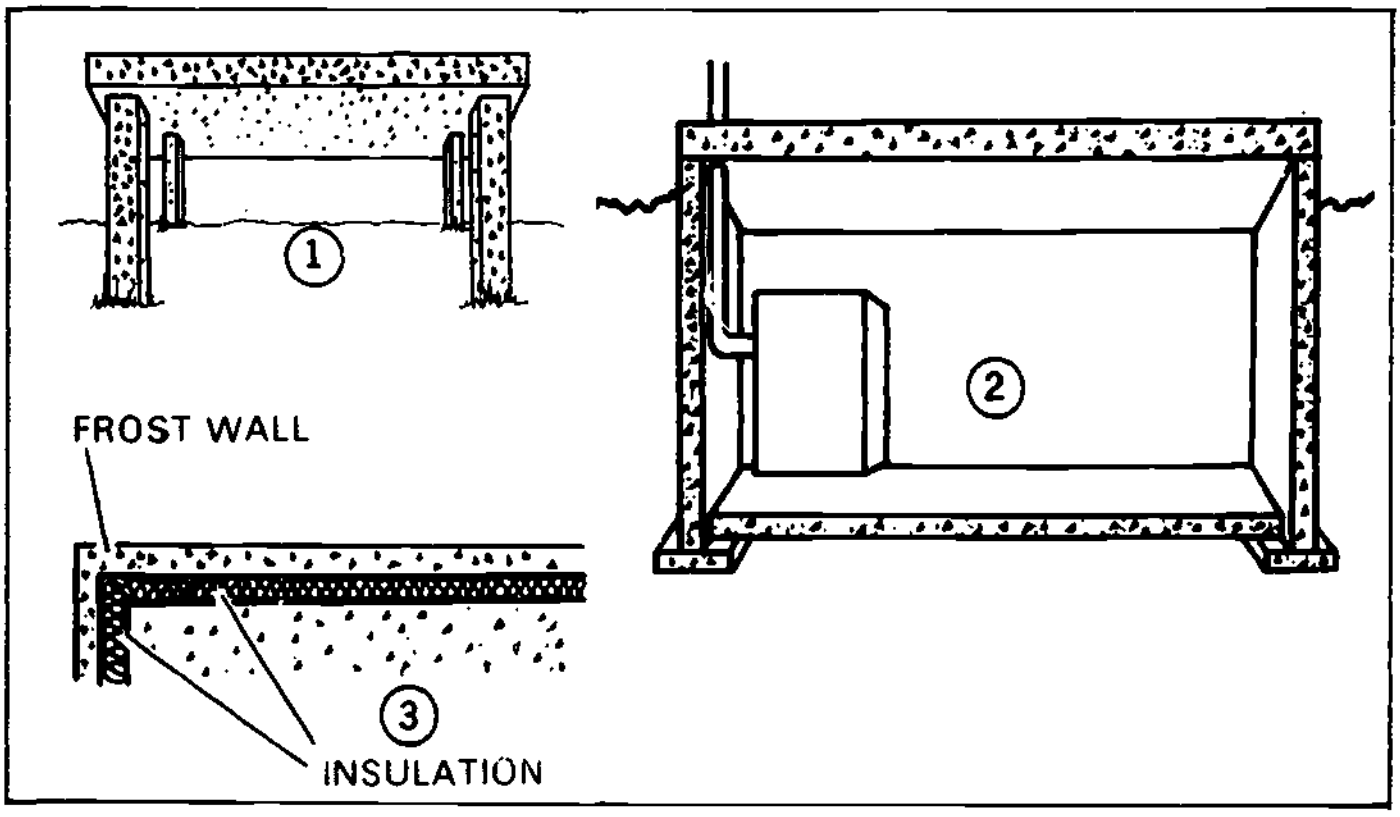


FIGURE 2

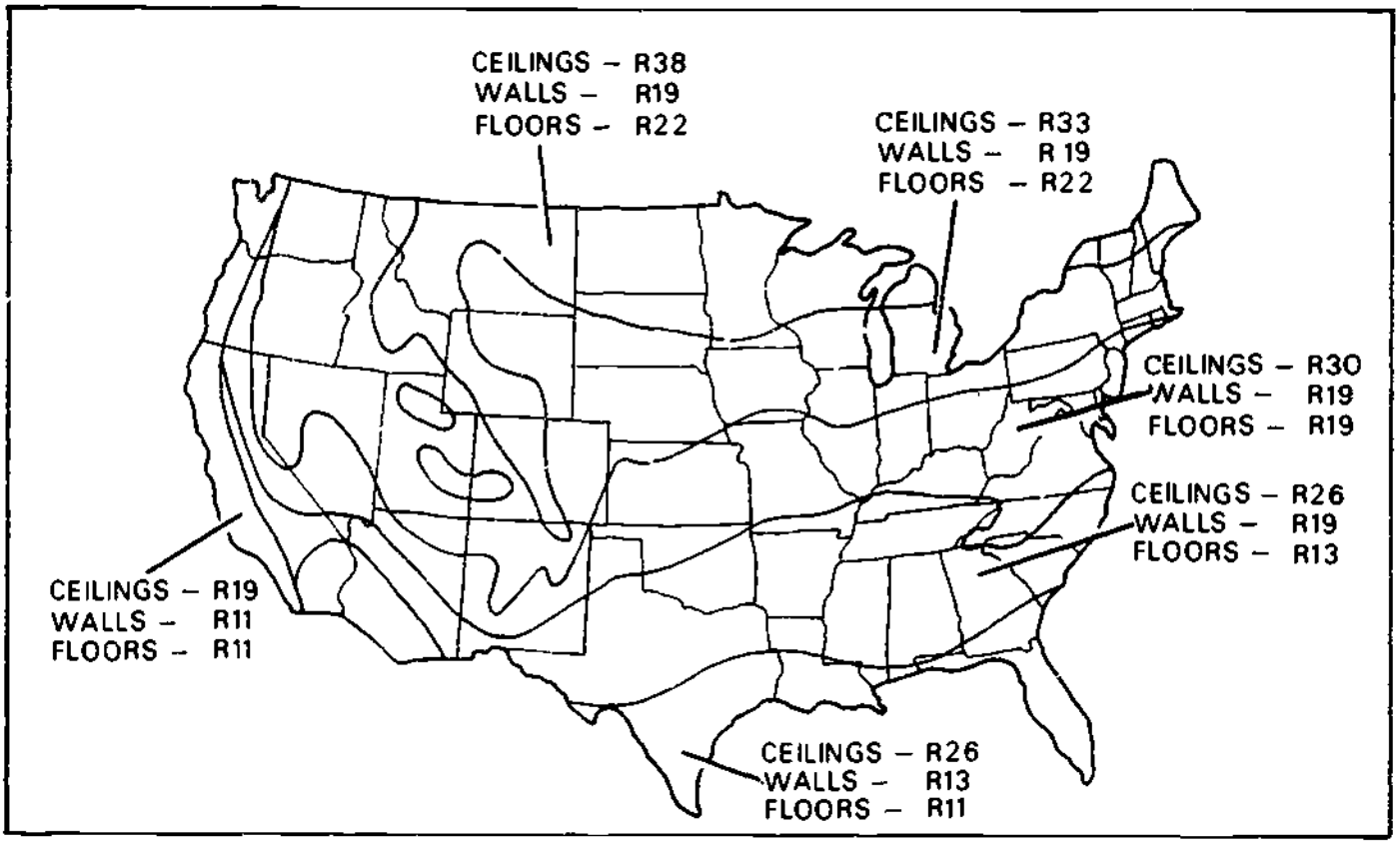


FIGURE 3

C. What Construction Materials to Use

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part Three, Page 24)

STUDENT STUDY GUIDE OR TEST:

Circle the letter(s) that represent the correct answer(s), unless instructed otherwise.

1. Building materials should have the following characteristics:

   a. Weather protection.
   b. Insulating.
   c. Durable.
   d. Available.
   e. Economical.
   f. All of the above.

2. Fiberglass insulation quality is:

   a. Poor.
   b. Excellent.
   c. Average.

3. Brick and masonry insulation qualities are:

   a. Poor.
   b. Excellent.
   c. Average.

4. Window glass insulation qualities are:

   a. Poor.
   b. Excellent.
   c. Average.

5. Most insulation is:

   a. Simple to install.
   b. Difficult to install.
   c. Neither.

EXERCISE:

Visit your local building supplier and report cost and availability of some building materials.

D. What Type and How Much Insulation to Use

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part Three, Pages 24-34)

Circle the letter(s) that represent the correct answer(s), unless instructed otherwise.

1. The purpose of insulation is to:

   a. Increase heat transfer.
   b. Reduce heat transfer.
   c. Improve appearance.

2. Energy moves from:

   a. A high to a low temperature.
   b. Top to bottom.
   c. A low to a high temperature.

3. Insulation quality is usually based on the amount of:

   a. Glass.
   b. Vapor barrier.
   c. Air space within the insulation.

4. R-value is:

   a. The resistance to air flow.
   b. The rate of heat transfer.
   c. The resistance to energy flow.

5. Types of insulation are as follows:

   a. Fiberglass.
   b. Rock wool.
   c. Cellulose.
   d. Polyurethane.
   e. All of the above.

6. Characteristics of insulation to look for are:

   a. Fire resistance.
   b. R-value.
   c. Form.
   d. All of the above.

7. Forms of insulation are:

   a. Blankets.
   b. Batts.
   c. Loose-fill.
   d. Masonry.
   e. All of the above.

8. Blown-in insulation comes in:

   a. Batts.
   b. Plastic sheets.
   c. Loose-granules or cellulose.

9. Fiberglass comes in:

   a. Rolls.
   b. Batts.
   c. Both.

10. Rock wool is made from:

    a. Rocks.
    b. Wool.
    c. Cellulose.

11. The R-value of insulation sheathing per inch thickness is:

    a. 10.
    b. 6.
    c. 2.

12. Cellulose fiber:

    a. Is fire resistant.
    b. Must be treated for fire resistance.
    c. Comes in batts.

13. Polystyrene has an R-value per inch thickness of:

    a. 4 to 5.
    b. 5 to 10.
    c. 2 to 3.

14. Blue polystyrene has a higher R-value than white.

    a. True.
    b. False.

15. Polystyrene must:

    a. Never be covered with other material.
    b. Always be covered with other material.
    c. Have brick siding.

16. Urea-formaldehyde is:

    a. Blankets.
    b. Blown in.
    c. Sheets.

17. From Figure 3, page 44, indicate R-values recommended for your area:

    a. Ceilings. _____
    b. Walls. _____
    c. Floors. _____

18. Two methods providing more insulation in walls are:

    a. Use 6 inch studs.
    b. Use 4 inch studs and add sheet insulation to outside.
    c. Use 4 inch studs and add blown-in insulation.

EXERCISE:

Visit your local supplier and report on cost and availability of insulation. List the following:

Type of insulation.
R-value.
Certificate of fire resistance.
Cost.

E. What Type of Vapor Barrier to Use

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part Three, Pages 34-35)

STUDENT STUDY GUIDE OR TEST:

Circle the letter(s) that represent the correct answer(s), unless instructed otherwise.

1. Three types of vapor barriers are:

   a. Polyethylene film.
   b. Aluminum foil.
   c. Paints.
   d. None of the above.

2. Polyethylene film is available in thicknesses of:

   a. 2-6 mils.
   b. 3 1/2 to 4 inches.

3. Paints are used as a vapor barrier:

   a. In old buildings.
   b. In hallways.
   c. In new construction.

EXERCISE:

Visit your local supplier and report on type and availability of vapor barriers.

F. What Type and How Much Weatherstripping and Caulking to Use

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part Three, Pages 35-40)

STUDENT STUDY GUIDE OR TEST:

Circle letter(s) that represent the correct answer(s), unless instructed otherwise.

1. Three advantages of caulking and weatherstripping are to:

   a. Increase the U-value of walls.
   b. Reduce the air exchange.
   c. Keep out insects.
   d. Reduce energy use.
   e. All of the above.

2. Weatherstripping is used on:

   a. Doors and windows that open and close.
   b. Cracks around window frames.
   c. Soffit vents.

3. Types of weatherstripping are:

   a. Pressure sensitive foam.
   b. Metal spring.
   c. Felt.
   d. Flexible plastic.
   e. All of the above.

4. Weatherstripping and caulking are:

   a. Easy to install.
   b. Difficult to install.

5. All caulking is the same.

   a. True.
   b. False.

6. Types of caulking most desirable are:

   a. Latex base.
   b. Butyl hose.
   c. Neoprene rubber.
   d. All of the above.

7. Weatherstripping and caulking should be done:

   a. As a last resort.
   b. Frequently.

EXERCISE:

Visit your local supplier and report on types and availability of caulking and weatherstripping.

G. What Type of Windows to Use

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part Three, Pages 41-46)

STUDENT STUDY GUIDE OR TEST:

Circle the letter(s) that represent the correct answer(s), unless instructed otherwise.

1. Types of windows are as follows:

   a. Double hung.
   b. Horizontal sliding.
   c. Casement.
   d. Awning.
   e. All of the above.

2. Aluminum-frame windows have a lower R-value than wooden frame windows.

   a. True.
   b. False.

3. Jalousie windows are energy efficient.

   a. True.
   b. False.

4. Window space in a building:

   a. Improves energy efficiency.
   b. Reduces energy efficiency.
   c. Makes no difference in energy efficiency.

5. To improve the efficiency of windows:

   a. Add storm windows.
   b. Install triple glazed windows.
   c. Add plastic sheeting.
   d. None of the above.

6. Windows may lose energy by:

   a. Excessive heat conduction.
   b. Infiltration.
   c. Improper shades and drapes.
   d. Improving R-value.

7. Windows help prevent infiltration.

   a. True.
   b. False.

EXERCISE:

Visit your local supplier and report on type and availability of windows.

H. What Type of Doors to Use

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part Three, Pages 46-48)

STUDENT STUDY GUIDE OR TEST:

Circle the letter(s) that represent the correct answer(s), unless instructed otherwise.

1. Types of doors are as follows:

   a. Hollow-core.
   b. Solid wood.
   c. Steel-clad, foam-center.
   d. Two of the above.

2. The best insulating door is the:

   a. Hollow-core.
   b. Solid wood.
   c. Steel-clad, foam-center.

3. The best insulating storm door is:

   a. Metal and glass.
   b. Wood and glass.
   c. Solid metal.

EXERCISE:

Visit your local supplier and report on type and availability of doors.

I. What Type of Heating Equipment to Use

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part Three, Pages 49-56)

STUDENT STUDY GUIDE OR TEST:

Circle the letter(s) that represent the correct answer(s), unless instructed otherwise.

1. Common types of space heating equipment are:

   a. Electric resistance.
   b. Gas furnace.
   c. Oil furnace.
   d. Heat pump.
   e. All of the above.

2. Electric resistance heating systems may be which of the following types:

   a. Steam.
   b. Baseboard.
   c. Heat pump.

3. The most popular source of space heating are the:

   a. Gas and oil furnaces.
   b. Heat pump.
   c. Hydronics.

4. The heat pump when heating works like a refrigerator in reverse.

   a. True.
   b. False.

5. Heat pumps take heat from the air when temperatures are as low as:

   a. 15°F.
   b. 10°F.
   c. 0°F.

6. Electricity is less efficient because of:

   a. Low efficiency of equipment.
   b. Energy loss in generation.
   c. More costs.

7. Match the following:

   a. Oil.
   b. Gas.
   c. Coal.
   d. Wood.
   e. Electricity.

   __Limited to specific locations.
   __Good thermal efficiency, 50-70%.
   __Most commonly used.
   __Overall efficiency, 25-35%.
   __Reserves offer greatest availability.

8. Which of the heating systems have the greatest potential for overall efficiency?

   a. Electric.
   b. Gas.
   c. Oil.
   d. Heat pump.

9. The total consumption of energy varies in different parts of the U.S.

   a. True.
   b. False.

10. The cost of energy varies in different parts of the U.S. with the different systems.

    a. True.
    b. False.

EXERCISE:

Compare heating and cooling cost of residences with members of your class.

J. What Type of Air Conditioners to Use if Needed

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part Three, Pages 57-61)

STUDENT STUDY GUIDE OR TEST:

Circle the letter(s) that represent the correct answer(s), unless instructed otherwise.

1. Parts of an air conditioner are:

   a. Compressor.
   b. Condenser.
   c. Evaporator.
   d. Storage Tank.

2. Types of air conditioners are:

   a. Forced-air system (central).
   b. Individual room units.
   c. Heat pumps.
   d. Fireplaces.

3. An evaporative cooling unit works well in hot-humid zones.

   a. True.
   b. False.

4. Attic fans can be thermostatically controlled.

   a. True.
   b. False.

5. Heat pumps are most desirable in cold climates.

   a. True.
   b. False.

6. When purchasing an air conditioning unit, get the highest:

   a. EER rating.
   b. AVA rating.
   c. Capacity possible.

7. The use of air conditioning in the U.S. is:

   a. Increasing.
   b. Decreasing.

EXERCISE:

Visit your local supplier and report on type and availability of air conditioners. What are the EER ratings?

K. What Type of Ventilation to Use

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part Three, Pages 62-66)

STUDENT STUDY GUIDE OR TEST:

Circle the letter(s) that represent the correct answer(s), unless instructed otherwise.

1. Reduced ventilation saves energy in cold weather.

   a. True.
   b. False.

2. The primary ventilation need is:

   a. Living room.
   b. Attic.
   c. Hall.

3. The main purpose of ventilation is to:

   a. Remove moisture.
   b. Increase moisture.
   c. Improve heating efficiency.

4. Types of attic ventilation are:

   a. Static ventilators.
   b. Power ventilation.
   c. Heat pump.

5. Natural ventilation can be accomplished by:

   a. Thermal effect.
   b. Wind direction.
   c. Wind pressure.
   d. All of the above.

6. Types of static attic ventilators are:

   a. Soffit vents.
   b. Ridge vents.
   c. Electric fan.

7. Power ventilators are to be used:

   a. At all times.
   b. When static systems are not installed.
   c. With cathedral ceilings.

8. Basement ventilators are used to remove:

   a. Moisture.
   b. Dust.
   c. Heat.

9. Static attic ventilators should be used:

   a. Summer only.
   b. Winter only.
   c. Summer and winter.

EXERCISE:

Visit your local supplier and report on types and availability of attic ventilators. What are the EER ratings of the electric fans?

L. What Type of Lighting to Use

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part Three, Pages 67-68)

STUDENT STUDY GUIDE OR TEST:

Circle letters representing correct answers, unless instructed otherwise.

1. Lighting consumes what percent of home energy?

   a. 3%.
   b. 10%.
   c. 20%.

2. Which is the most energy efficient?

   a. Natural lighting.
   b. Electric lights.
   c. Gas lighting.

3. Which is the most energy efficient?

   a. Incandescent.
   b. Fluorescent.
   c. High intensity.

EXERCISE:

Compare power requirements and efficiencies of different light bulbs.

M. What Type of Water Heater to Use

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part Three, Pages 70-71)

STUDENT STUDY GUIDE OR TEST:

Circle the letters representing the correct answers, unless instructed otherwise.

1. Water heaters are a major user of energy.

   a. True.
   b. False.

2. Temperature setting on a water heater should be:

   a. 140-160°F.
   b. 120-140°F.
   c. 150-160°F.

3. Solar energy is a likely alternative to water heating.

   a. True.
   b. False.

EXERCISE:

Check the temperature setting on your water heater at home and report to the class.

N. What Type of Plumbing to Use

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part Three, Pages 72-75)

STUDENT STUDY GUIDE OR TEST:

Circle letters representing correct answers, unless instructed otherwise.

1. Which plumbing fixtures consume the most water?

   a. Laundry.
   b. Toilets.
   c. Lavatories.

2. Flow control valves save water.

   a. True.
   b. False.

3. A dripping faucet should be ignored.

   a. True.
   b. False.

EXERCISE:

Visit your local plumbing fixture supply and report on energy-saving fixtures and appliances that are available.

A. 1. Installing Insulation in the Ceiling

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part Three, Pages 75-83)

STUDENT STUDY GUIDE OR TEST:

Circle letter representing correct answer, unless instructed otherwise.

1. Insulation should be installed in a new or remodeled building:

   a. As each component part is completed.
   b. After all framing is done and electrical, plumbing, heating and cooling are roughed in.
   c. After the building is completed.

2. The purpose of insulation is to:

   a. Keep out moisture.
   b. Strengthen the structure against wind and snow load.
   c. Improve the thermal efficiency.

3. Insulation should be placed in the following ceilings:

   a. All ceilings.
   b. Only ceilings exposed to unheated attics or directly covered by roofs.
   c. Only ceilings directly covered by roofs.

4. For buildings which have no attic and insulation is installed next to the roof:

   a. Air space is required between insulation and roof.
   b. Air space is not required.
   c. Air space is required between insulation and ceiling.

5. What types of insulation may be used in the ceiling?

   a. Flexible insulation.
   b. Loose-fill insulation.
   c. Rigid insulation.
   d. Reflective insulation.
   e. All of the above.

6. If the insulation has a vapor barrier, the vapor barrier should be placed:

   a. Next to the heated side.
   b. Next to the exposed (cold) side.
   c. Doesn't matter.

7. Vapor barriers should:

   a. Have holes punched for air circulation.
   b. Have no holes or torn places.

8. Blanket insulation comes in rolls up to 3 1/2 inches thick and 16 or 24 inches wide.

   a. True.
   b. False.

9. Batt insulation comes in sections up to 6 inches thick and 16 to 24 inches wide.

   a. True.
   b. False.

10. Blanket insulation with a paper or vapor barrier (non-foil) backing may be stapled:

    a. To the outside of the joists.
    b. To the inside edge of the joists.
    c. Either way.

11. If the vapor-barrier backing is a reflective foil:

    a. The backing must be stapled to the inside edge of the joists and an air space provided.
    b. The backing must be stapled to the outside edge of the joist.

12. When installing a blanket or batt insulation:

    a. Leave spaces between joists for expansion.
    b. Pack insulation in tightly.
    c. Place insulation loosely, leaving no spaces between joists or around receptacles and pipes.

13. When adding flexible insulation to the ceiling:

    a. Lay all blankets or batts parallel to joist.
    b. Lay insulation parallel to joists until space is filled, then lay extra at right angles to joist.
    c. Lay all insulation at right angles to joists.

14. When installing flexible insulation:

    a. Wear short sleeve and loose fitting clothes.
    b. Wear a chemical respirator.
    c. Wear safety goggles, dust mask, and clothes that fit tight around the neck and wrists.

15. When installing flexible or loose-fill insulation in the attic:

    a. Be sure and pack insulation against the cornices to prevent air from entering the attic through the soffit vents.
    b. Avoid restricting attic ventilation through the soffit vents.

16. Recessed light fixtures must be protected against contact with insulation.

    a. True.
    b. False.

17. When using loose-fill insulation, vapor barriers are not required.

    a. True.
    b. False.

18. Loose-fill insulation may be installed by:

    a. Pouring.
    b. Blowing.
    c. Either.

19. Rigid insulation is used:

    a. Where the roof and ceiling structure is one such as cathedral ceilings.
    b. Between stories.

20. A combination of rigid and flexible insulation may be used in sloped ceilings framed with rafters.

    a. True.
    b. False.

21. To be effective, reflective insulation must have an air space between the reflective surface and any other surface next to it.

    a. True.
    b. False.

22. In Figure 4, page 60, indicate type and location of insulation to be installed in the ceiling.

EXERCISE: Installing Insulation in the Ceiling

Your teacher will provide different types of insulation, a section of a ceiling, tools and safety equipment.

Install a section of insulation as directed. Follow procedures given in the manual.

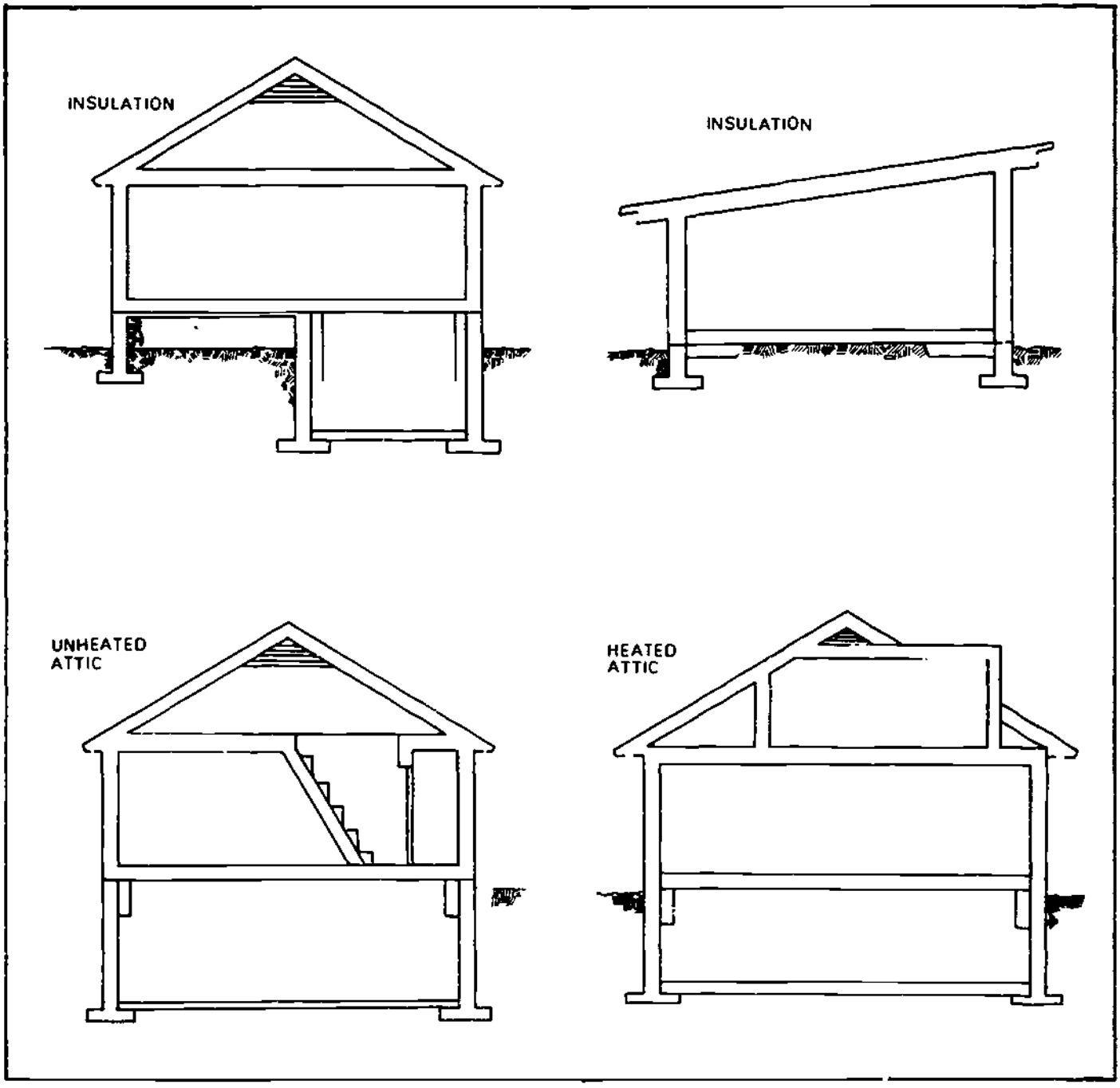


FIGURE 4

A. 2. Installing Insulation in the Floor

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part Three, Pages 83-85)

STUDENT STUDY GUIDE OR TEST:

Circle letter representing correct answer, unless instructed otherwise.

1. Insulation should be installed in floors:

   a. Exposed to unheated areas only.
   b. Wherever they are found.
   c. Only if they are made of hardwood.

2. What types of insulation are generally used in floors?

   a. Flexible.
   b. Rigid.
   c. Reflective.
   d. All of the above.

3. Flexible insulation is easier to install in floors:

   a. Before the subfloor is laid.
   b. After the house is finished.

4. Flexible insulation with vapor barrier backing has:

   a. The vapor barrier installed toward the ground.
   b. The vapor barrier installed next to the heated side.

5. Flexible insulation is supported under finished floors by:

   a. Heavy gage (stiff) wire.
   b. Wire mesh.
   c. Either of the above.

6. Loose-fill insulation is not generally used in floors.

   a. True.
   b. False.

7. Rigid insulation may be used in the following types of floors:

   a. Existing slab floors.
   b. Wood floors.
   c. New slab floors.
   d. All of the above.

8. Rigid insulation is placed under the vapor barrier under concrete slab floors.

   a. True.
   b. False.

9. In Figure 4, page 60, indicate type and location of insulation to be installed in the floor.

EXERCISE: Installing Insulation in the Floor

Your teacher will provide different types of insulation, a section of flooring, tools and safety equipment.

Install a section of insulation as directed. Follow procedures given in the manual.

A. 3. Installing Insulation in the Walls

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part Three, Pages 86-89)

STUDENT STUDY GUIDE OR TEST:

Circle letter representing correct answer, unless instructed otherwise.

1. Insulation should be placed in the following walls:

   a. All walls.
   b. Only walls exposed to unheated areas.
   c. Only brick walls.

2. What types of insulation may be used in walls?

   a. Flexible.
   b. Loose-fill.
   c. Rigid.
   d. Reflective.
   e. Foam.
   f. All of the above.

3. If the insulation has a vapor barrier, the vapor barrier should be placed:

   a. Next to the exposed (cold) side.
   b. Next to the heated side.
   c. Doesn't matter.

4. Vapor barrier should:

   a. Have no holes or torn places.
   b. Have holes punched for air circulation.

5. Blanket insulation with a paper vapor barrier (non-foil) backing may be stapled:

   a. To the outside of the stud.
   b. To the inside of the stud.
   c. Either way.

6. If the vapor barrier backing is a reflective foil:

   a. The backing must be stapled to the inside edge of the studs and an air space provided.
   b. The backing must be stapled to the outside edge of the studs.

7. When installing blanket or batt insulation:

   a. Leave spaces between joists for expansion.
   b. Pack insulation tightly around receptacles and pipes.
   c. Place insulation loosely, leaving no space between joists or around receptacles and pipes.

8. Wood is just as good an insulator as fiberglass.

   a. True.
   b. False.

9. Safety equipment to be worn when installing flexible insulation in walls include:

   a. Short sleeve and loose fitting clothes.
   b. Chemical respirator.
   c. Safety goggles, dust mask and clothes that fit tightly around neck and wrists.

10. When installing loose-fill insulation in walls in old buildings:

    a. Fill to fire stop from top.
    b. Fill to fire stop from bottom.
    c. Check for fire stop and fill both sides.

11. When using rigid insulation on walls:

    a. No other insulation is needed.
    b. It is usually used in conjunction with other type insulation.

12. When using rigid insulation:

    a. Corner bracing is usually necessary.
    b. Corner bracing is not necessary.

13. Rigid insulation is available in the following types:

    a. Accordion.
    b. Reflective one side.
    c. Reflective both sides.
    d. All of the above.

14. Urethane foams are sprayed on the job.

    a. True.
    b. False.

15. In Figure 4, page 60, indicate type and location of insulation to be installed in the walls.

EXERCISE: Installing Insulation in the Walls

Your teacher will provide different types of insulation, a section of wall, tools and safety equipment.

Install a section of insulation as directed. Follow procedures in the manual.

A. 4. Installing Insulation in the Basement and Crawl Space

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part Three, Pages 89-90)

STUDENT STUDY GUIDE OR TEST:

Circle letter representing correct answer, unless instructed otherwise.

1. Insulation should be placed in the crawl space walls:

   a. If the floor is insulated.
   b. To prevent rats and mice from entering.
   c. If the floor is not insulated.

2. What types of insulation should be used in the crawl space?

   a. Flexible.
   b. Loose-fill.
   c. Rigid.
   d. Reflective.

3. Place the vapor barrier:

   a. On the side next to the foundation wall.
   b. On the ground surface of crawl space.

4. When insulating the crawl space, never insulate the band joist.

   a. True.
   b. False.

5. If heating and cooling ducts are in the basement, it is not necessary to insulate the basement walls.

   a. True.
   b. False.

6. On masonry walls, flexible insulation:

   a. May be attached to furring strips on the foundation wall.
   b. May be used to fill cores of concrete blocks.
   c. May be stapled to concrete block.

7. Loose-fill insulation is used only to pour into cores of concrete blocks.

   a. True.
   b. False.

8. Rigid insulation may be glued to masonry walls.

   a. True.
   b. False.

9. In Figure 4, page 60, indicate type and location of insulation to be installed in the crawl space and basement.

EXERCISE: Installing Insulation in the Basement and Crawl Space

Your teacher will provide different types of insulation, a section of basement wall or crawl space, tools and safety equipment.

Install a section of insulation as directed. Follow procedures in the manual.

B. Installing Vapor Barriers

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part Three, Pages 91-92)

STUDENT STUDY GUIDE OR TEST:

Circle letter representing correct answer, unless instructed otherwise.

1. The purpose of the vapor barrier is to:

   a. Prevent water vapor from condensing on the warm side.
   b. Keep insulation dry.
   c. Keep structure dry.
   d. All of the above.

2. In Figures 5, page 66, indicate the location of vapor barriers (consider the buildings are in a cold climate).

3. Vapor barriers also help reduce air infiltration.

   a. True.
   b. False.

4. Vapor barriers should have some scatter holes for ventilation.

   a. True.
   b. False.

5. Aluminum paint may be applied to old ceilings to provide a vapor barrier.

   a. True.
   b. False.

6. Two vapor barriers are better than one.

   a. True.
   b. False.

7. Types of vapor barriers are as follows:

   a. Polyethylene film.
   b. Aluminum foil.
   c. Waterproof paints and other finishes.
   d. All of the above.

8. Some insulation is available with vapor barrier attached.

   a. True.
   b. False.

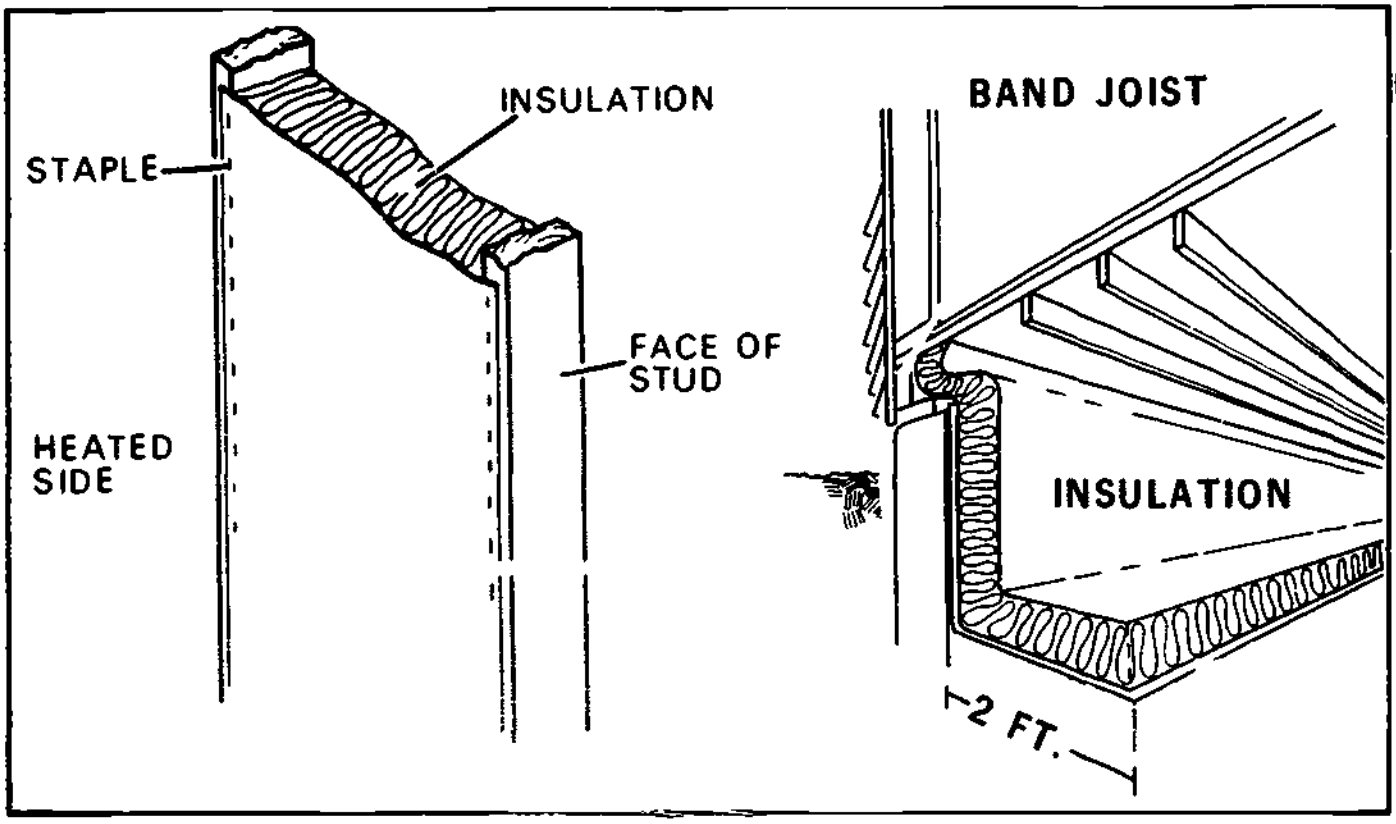


FIGURE 5

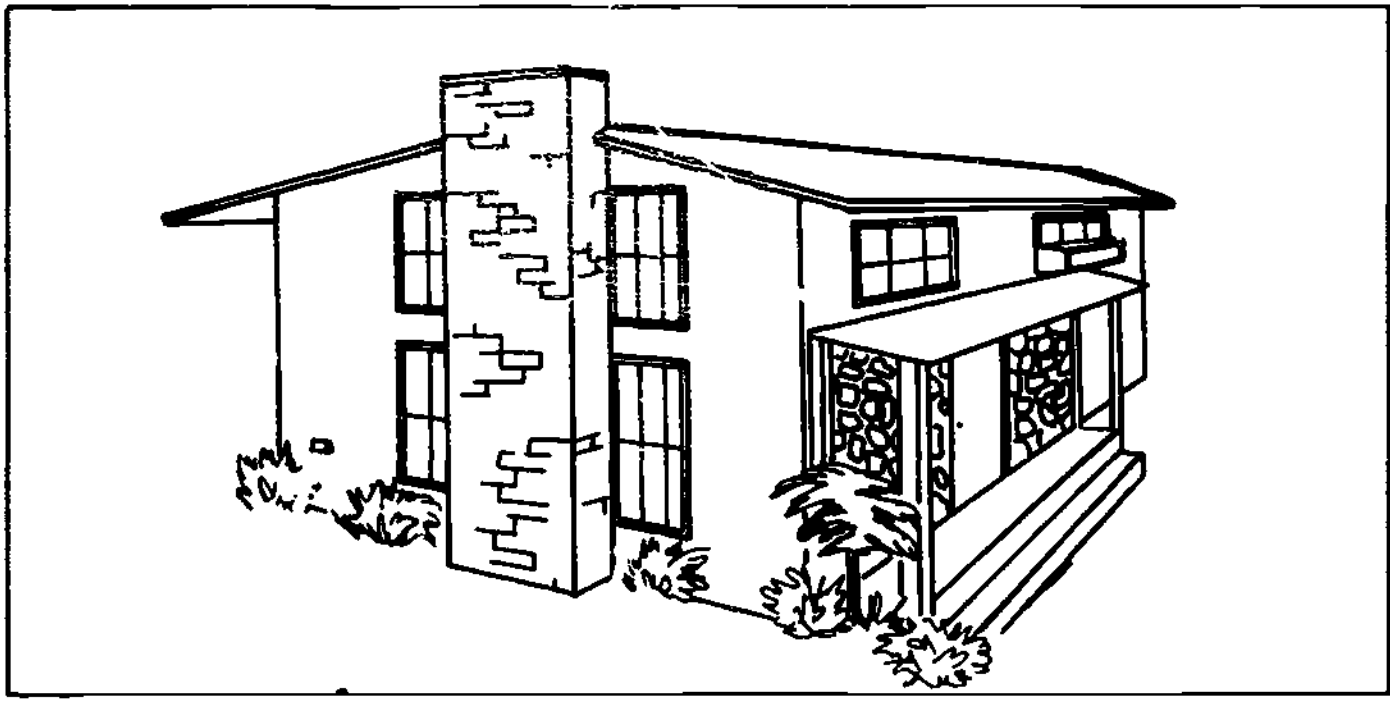


FIGURE 6

EXERCISE: Installing Vapor Barriers

Your teacher will provide vapor barrier material, a wall section, tools and safety equipment.

Install a section of vapor barrier as directed. Follow procedures in the manual.

C. Installing Weatherstripping and Caulking

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part Three, Pages 93-97)

STUDENT STUDY GUIDE OR TEST:

Circle letter representing correct answer, unless instructed otherwise.

1. The purpose of weatherstripping and caulking is to reduce _____.

2. Weatherstripping is used primarily on _____ and _____.

3. Adjustable thresholds are available to reduce infiltration under doors.

   a. True.
   b. False.

4. Weatherstripping procedures vary with the type of window.

   a. True.
   b. False.

5. Types of weatherstripping are as follows:

   a. Adhesive-backed foam.
   b. Felt strips.
   c. Foam-edged wood.
   d. Spring metal.
   e. All of the above.

6. Caulking is used to stop cracks in outside walls whenever they occur.

   a. True.
   b. False.

7. Weatherstripping may be:

   a. Self-adhesive.
   b. Tacked on.
   c. Either.

8. Caulking gun should be held at:

   a. 20 degree angle.
   b. 45 degree angle.
   c. 90 degree angle.

9. Move caulking gun away from the direction in which it is pointed.

   a. True.
   b. False.

10. In figure 6, page 66, indicate the points where caulking may be needed.

EXERCISE: Installing Weatherstripping and Caulking

Your teacher will provide weatherstripping and caulking, a section of wall, tools and safety equipment.

Install a section of weatherstripping and caulking as directed. Follow procedures in manual.

D. Installing Storm Windows and Doors

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part Three, Pages 97-102)

STUDENT STUDY GUIDE OR TEST:

Circle letter representing correct answer, unless instructed otherwise.

1. Window glass is a poor insulator.

   a. True.
   b. False.

2. Types of storm windows are as follows:

   a. Glass with wooden frames.
   b. Glass with aluminum frames.
   c. Rigid plastic.
   d. Flexible plastic.
   e. All of the above.

3. Glass with aluminum frames is the most durable.

   a. True.
   b. False.

4. Glass with aluminum frames may be purchased as:

   a. Solid glass.
   b. Double sash.
   c. Triple sash.
   d. All of the above.

5. When fitting storm windows, measure:

   a. One window and get storm windows for all windows the same size.
   b. All windows and fit each individual window.

6. Double glazing combination windows will reduce heat loss by:

   a. 1/10.
   b. 2/3.
   c. 1/2.

7. Aluminum combination storm windows can be used on:

   a. All types of windows.
   b. Only double hung or horizontal sliding glass.
   c. Awning type windows.

8. Flexible plastic is:

   a. An inexpensive temporary installation.
   b. A permanent type installation.

9. Flexible plastic may be installed:

   a. Inside.
   b. Outside.
   c. Either inside or outside.

10. Which is the most energy efficient?

   a. Wooden storm doors.
   b. Aluminum storm doors.

11. A storm door is hung on:

   a. The inside casing of the door to open inward.
   b. The outside casing of the door to open outward.

12. To install storm doors, screen doors must be:

   a. Left in place.
   b. Removed.

13. Aluminum storm doors are:

   a. Prehung in frames.
   b. Designed for hanging the same as wooden doors.

EXERCISE: Installing Storm Windows and Doors

Your teacher will provide a storm window and a storm door, tools and safety equipment.

Install storm windows and doors as directed. Follow procedures in the manual.

EXERCISE:

Visit your local supplier and report on type and availability of vapor barriers.

III. IMPROVING EFFICIENCY OF EQUIPMENT

(Ref. PROVIDING FOR ENERGY EFFICIENCY IN HOMES AND SMALL BUILDINGS, Part Three, Pages 103-111)

STUDENT STUDY GUIDE OR TEST:

Circle letter representing correct answer, unless instructed otherwise.

1. Energy conserving systems in buildings include the following:

   a. Heating systems.
   b. Cooling systems.
   c. Plumbing systems.
   d. Appliances.
   e. All of the above.

2. The efficiency of most energy conserving systems can be improved at nominal cost and a minimum of effort.

   a. True.
   b. False.

3. Fireplaces and chimneys are generally:

   a. Very energy efficient.
   b. Not energy efficient.

4. The energy efficiency of existing fireplaces can be improved by:

   a. Installing a tempered glass screen.
   b. Enlarging the size of the fireplace.

5. The energy efficiency of new fireplaces can be improved by:

   a. Providing for outside air.
   b. Installing a prefabricated steel circulating jacket.
   c. Either or both of the above.

6. The energy efficiency of stoves can be improved by:

   a. Providing for ample outside air.
   b. Providing a heat exchanger in the stove pipe.
   c. Circulating the air away from the stove with a low speed fan.
   d. All of the above.

7. The energy efficiency of forced air systems can be improved by:

   a. Purchasing a highly efficient furnace.
   b. Keeping filters clean.
   c. Having furnace checked periodically.
   d. Providing outside air to the burner if installed.
   e. All of the above.

8. Forced hot water heating systems are generally efficient.

   a. True.
   b. False.

9. The energy efficiency of heat pumps can be improved by:

   a. Purchasing highly efficient heat pump.
   b. Keeping evaporator and condenser coils clean.
   c. Both of the above.

10. The energy efficiency of cooling systems can be improved by:

   a. Purchasing poorly efficient units.
   b. Neglecting to keep units clean.
   c. Placing the condenser in the sun.
   d. None of the above.

11. Ventilating systems should be checked and cleaned each season.

   a. True.
   b. False.

12. The energy efficiency of plumbing systems can be improved by:

   a. Wrapping hot water pipes with insulation.
   b. Wrapping cold water pipes with insulation.

13. Hot water heaters use a large amount of energy in buildings.

   a. True.
   b. False.

14. The energy efficiency of hot water heaters can be improved by:

   a. Adding extra insulation around them.
   b. Providing for a supplemental tank.

15. Dripping faucets are energy efficient.

   a. True.
   b. False.

16. Energy can be saved by a wise selection of appliances.

   a. True.
   b. False.

EXERCISE:

Your teacher will provide some energy conserving systems.

Take an inventory of the systems and evaluate the efficiency of each. Suggest means of improving efficiency. Follow information in the manual.

SYSTEM	SUGGESTED MEANS OF IMPROVING EFFICIENCY