Energy Conservation in the Home

RENEWABLE ENERGY
THE INFINITE POWER OF TEXAS

For Grades 6, 7 and 8

OVERVIEW

In this unit, students will learn about ways to conserve energy in the home through building materials, such as insulation, windows and shading techniques, and by using efficient appliances in the home. Emphasis is given to the significant causes of heat loss in a home. Students will realize the importance of using proper insulation with a high R-value to reduce heat transfer. Students will conduct a simple experiment to test the differences in heat conduction among several materials.

OBJECTIVES

See Middle School Teacher Resource Guide for TEKS objectives and additional information regarding this and other middle school units.

SUGGESTED TIMEFRAME

Teacher will need to determine how many class periods to devote to each activity, based on the suggested timeframe and length of classes.

Time	Activity	Content Area
10 minutes	**Activity 1** – Teacher Introduction	
15 minutes	**Activity 2** – Assessment of Current Student Knowledge	Science
45 minutes	**Activity 3** – Reading Passage and Vocabulary **Homework Assignment** – Sentences with Vocabulary	Reading Vocabulary Language Arts
30 minutes	**Activity 4** – Pre-Lab	Science
30 minutes	**Activity 5** – Lab	
30 minutes	**Activity 6** – Post-Lab	Science
30 minutes	**Activity 7** – Assessment	Science

REQUIRED MATERIALS

- copy of the Reading Passage and Student Data Sheets (includes reading comprehension questions, vocabulary and Lab Activity) for each student
- copy of the Assessment Questions for each student
- graph paper
- an equipment kit for each group containing the following:
  - 2 spoons (one plastic, one metal)
  - 1 popsicle stick
  - 1 glass stirring rod (about same height as spoons)
  - 500 ml beaker
  - 500 ml hot water >85°C
  - timer or stop watch
  - 1 plastic knife
  - 4 thumbtacks
  - 1 ea. 1/4 inch square slice of saturated margarine or butter (in stick form), very cold or frozen (size of butter slice can vary depending on size of thumbtacks used)
  - goggles
  - 1 small piece of wax paper

TEACHER OVERVIEW

BACKGROUND INFORMATION

Conductors in the home include metals and glass. Ceilings and walls conduct heat from inside the house to outside. Insulation is a barrier to this conduction. There are conduction insulators, like clothing (jackets, sweaters); and there are convection insulators, like walls preventing warm air from moving out of the house in the winter and hot air from moving into a cool home in the summer. Radiation insulators can be window shades or curtains.

SUMMARY OF ACTIVITIES

Activity 1 – Teacher Introduction (10 minutes)

Explain to the class that for the next unit of study, they will be learning about ways to conserve energy in the home and the various materials, equipment and techniques that can be employed to conserve energy.

Activity 2 – Assessment of Current Student Knowledge (15 minutes)

To assess what students already know, prompt a class discussion based on the 3 questions listed below. Based on this discussion, create and display a graphic organizer of the points that were discussed, which can be displayed throughout the Unit of Study. Refer to the Teacher Resource Guide for sample organizers.

1. What is energy conservation and how can we achieve it in our home?
2. Does anyone know what insulation is and how and why it is used in our homes?
3. Are our homes completely airtight? When all the doors and windows are closed, can outside air still come in and can our inside air seep outside? What effect does this have on how much energy we use?

See Teacher Resource Guide for alternative or additional assessment activity.

Activity 3 – Vocabulary and Reading Passage (45 minutes)

Each student will need a copy of the Reading Passage and the Student Data Sheets, which include reading comprehension questions, vocabulary words and the Lab Activity. (As an alternative to making copies, the Study Data Sheets can be displayed so the entire class can view them and copy the information into their science notebook.) Instruct students to study the Reading Passage and complete the questions and vocabulary. This activity will help them learn about several ways we can conserve energy in our home, provide them a basic understanding of the importance of insulation and prepare them for the Lab Activity in which they will test the heat conductivity of certain materials. Key vocabulary words in the Reading Passage will assist them in understanding the Lab Activity instructions. For students who wish to learn more of the detailed principles about home building materials that can be used to conserve energy, direct them to the appropriate resources. Suggested resources are included in the Teacher Resource Guide. At the end of this activity, collect and grade the student's work. Return their graded work the following day.

Homework Assignment – Key Vocabulary List

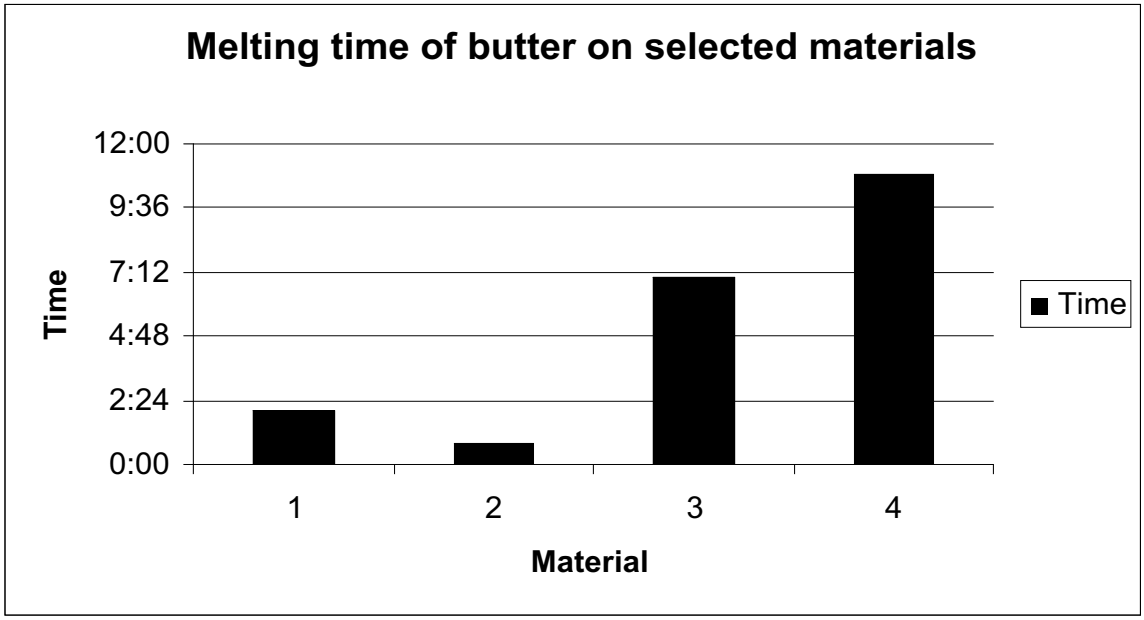
1. Instruct students to create in their science notebooks meaningful sentences that reflect an understanding of the definition of each vocabulary word. Students should have written the definition of the words in their science notebooks during class. See Teacher Resource Guide for alternative vocabulary homework.
2. Collect and grade this assignment the next day.

Activity 4 – Pre-Lab (30 minutes)

1. Explain to the class that the purpose of the Lab Activity is to gain an understanding of insulation and that different materials make better insulators than others. Before performing the lab, students can be given the lab instructions to read and summarize the steps involved. The summary can be in the form of a brief chart. Review safety guidelines before students conduct the lab. See Teacher Resource Guide for general safety guidelines. Demonstrate proper use and care of the equipment used in the activity. Discuss with students how they plan to create their graph and how they will label the axes.
2. Divide the class into equal small groups to conduct the Lab Activity. To ensure that all students participate, instruct the groups to assign who will be responsible for each step in the activity before beginning.

Activity 5 – Lab Activity (30 minutes)

1. Instruct each group to obtain the materials for one Lab Activity kit. Note that the recommended water temperature for the activity is at least 85°C (approximately 185°F). Inform students of safety precautions when handling the water or teacher may opt to pour the hot water for the students.
2. Instruct students to follow the directions outlined in the Lab Activity.
3. Confirm that the students have recorded their time and temperature measurements and observations in their Lab Report Form, as well as answers to the lab questions. If teacher thinks students will need it, review how to calculate range and average with the class.
4. Distribute graph paper to each student. Instruct students to graph their results on the graph paper. A sample graph is provided below with material plotted on the x-axis and time plotted on the y-axis. Although students worked in teams to obtain the data measurements, each student should complete his or her own graph.



Recommendations and expected observations

The plastic and metal spoons, the glass rod and the popsicle stick should be approximately equal in height. The margarine or butter should be very cold, even frozen if possible. The best conductor will release the thumbtack first (metal spoon) and the best insulator will be the material that holds the thumbtack for the longest time (will vary depending on thickness and type used).

Activity 6 – Post-Lab (30 minutes)

After students have completed their Lab Report Forms and their graphs, discuss their results. You may ask each group to summarize to the class their results.

Activity 7 – Assessment (30 minutes)

Distribute a copy of the Assessment Questions to each student. Instruct each student to work alone and answer the short answer and multiple-choice questions. Collect the handouts, grade and return them to the students.

ADDITIONAL ACTIVITIES

1. **Internet Research – Energy Conservation**
   Students can research information available on the Internet about energy conservation. Suggested web sites are included in the Teacher Resource Guide. You may divide the class into 4 groups and assign each group to a particular topic. Each group can create a display of the information that they found and provide a short summary of their findings. Suggested group topics include:
   Group 1 – Expand the concept of energy conservation in the home to the school. Students can identify an energy conservation measure that their school could benefit from (such as motion detector switches in restrooms, lowering or raising the temperature settings, or adding overhangs or solar shades to south-facing windows) and prepare a summary of their recommendation. The summary should include a description of their recommended measure, how to implement it in the school, and how it would benefit the school.
   Group 2 – Students can research areas of the U.S. that employ energy conservation techniques for new building construction. Programs to support green building techniques can be explored. Students should also research their own city's and/or state's policies or programs to encourage energy conservation in new building construction.
   Group 3 – Students can research the types of materials and other construction techniques used in constructing green buildings.
   Group 4 – Students can research landscaping techniques that can help lower home energy costs.

2. **Building Materials in my Home**
   This activity will require the assistance of an adult at home. Based on the building materials and techniques studied in the Reading Passage, students can investigate the type of building materials or techniques that were used in their homes. Students can also provide suggestions regarding how their home could benefit from improved materials or new practices. Suggested materials and techniques are as follows:

3. **Energy Conservation Questionnaire**
   Instruct students to create a questionnaire with the whole class regarding R-value home insulation, radiant barrier, sealing air leaks, etc. for a homeowner. Review the questionnaire and then have the students administer it to their parents or a homeowner. When the students

Material/ Technique	Current	Suggested
Insulation in attic	R-Value: _____ Thickness: _____	R-Value: _____ Thickness: _____
Windows	# of panes: _____	# of panes: _____
Overhangs		
Solar Screens		
Air Conditioner	Efficiency: _____	Efficiency: _____
Refrigerator	Efficiency: _____	Efficiency: _____
Light bulbs	Type: _____ Watts:_____	Type: _____ Watts:_____

have returned their completed questionnaires, compile the class results.

4. **Early Energy Conservation**
   Native Americans in the southwestern United States used a variety of shelters. Instruct students to research and write a report on the types of housing used by Native Americans, pointing out any elements of passive heating, venting, cooling, and insulation used. Wintering and summering site temperatures should be included.

Energy Conservation in the Home

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HIGHLIGHTS

- **Heating and cooling are the biggest part of an energy bill**
- **Insulation and high performance windows save energy and money**
- **Air leaks waste energy**
- **Overhangs are effective shading devices**
- **Choose high efficiency appliances**
- **Venting the attic saves cooling energy**

SUMMARY

Did you know that heating and cooling a home in Texas accounts for about 45% of a household's annual energy bill? (See Fig. 1) There are many products available that allow you to save energy in your home. Saving energy is far easier and often cheaper than producing it. Saving energy can be done by installing energy efficient appliances and high performance windows, sealing unwanted gaps or openings and adding the right type of insulation.

INSULATION

Insulation is one way to save energy. Whether the insulation is made of fiberglass, shredded newspapers or foam, it is one of the best investments a homeowner can make. Homeowners can install proper insulation in the ceiling, walls and floor. During the summer, insulation will minimize the amount of hot air from outside that enters the home, and it can keep the cool, air-conditioned air inside. Similarly, in the winter, insulation minimizes the cold air from outside that enters the home and keeps the warmed air inside. Insulation is rated by the R-value, which is determined by how well the insulation resists or slows the transfer of heat. The greater the R-value, the more effective it is at slowing heat transfer.

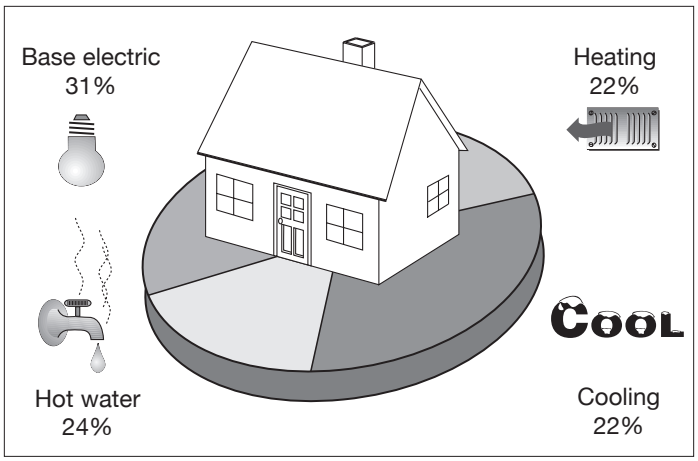


FIG. 1. ENERGY USE IN TYPICAL TEXAS HOME: *45% for heating and cooling, 24% for heating water, 31% for base electric use (fridge 10%, cooking 5%, clothes dryer 5%, other 11%)*

BEST INSULATION VALUES FOR NEW HOMES	
Location	**Walls / Ceilings**
Dallas and Fort Worth	R13 / R38
Amarillo	R13 / R38
San Antonio	R11 / R30
Corpus Christi	R11 / R30
Brownsville	R11 / R30

TABLE 1. *Best insulation values for new homes based on climate.*

Experts recommend using at least R-30 in the ceilings, R-13 in the walls and R-11 in the floor, but the best R-value depends on the climate in which you live. (See Table 1 for specific R-values in different Texas climate zones.) Insulation is most easily installed when a home is being built. For existing homes, the easiest and most effective place to add extra insulation is in the attic. If your home has less than 3 inches of insulation in the attic, extra fiberglass batts can be laid on top of the existing insulation or additional material can be blown into the attic. It is just as important to put insulation around the attic ducts and hot water pipes. This will save heating and cooling energy in the ducts and could help prevent pipes from freezing and bursting in the winter.

SEALING

Whether the season is winter or summer, air can leak out of a house in many ways. These air leaks waste energy and can account for nearly half of all heating and cooling costs in a home. Outside air can enter the home wherever different materials meet. One such place is where the door and the doorjamb meet. Fortunately, sealing air leaks is an easy and inexpensive task that requires little or no special equipment. Caulk is one of the cheapest and most effective materials for saving energy and should be applied around every window and doorframe. Even places in the walls where electrical wires and water plumbing enter the home can be a source of air leaks. Seal all electrical and plumbing connections that enter the home and fill any gaps in electrical outlets with foam insulation. Air ducts in your home that are pathways for heated and cooled air can also be a source of air leaks. Insulating and sealing ducts can be one of the most cost-effective means to save energy.

KEEPING THE HEAT OUT

Preventing the hot summer sun from entering the home during the summer is not easy. Installing high-performance windows, radiant barriers and solar shades can minimize heat from the sun that enters your home. In this way, homeowners can reduce the amount of sun-generated heat that enters the home.

WINDOWS

In the summer months in Texas, about 40% of the unwanted heat that enters your home comes in through your windows. Windows can now be made using special materials and design that minimize the amount of heat passing from outside the home to the interior. The amount of heat that a window allows to pass through it is rated by the U-value. A window with a lower U-value means that it allows less heat to pass through it.

What allows less heat to pass through a window? Windows can be coated or glazed with special materials that reduce heat transfer. The material framing the window can be designed in such a way and with special materials to minimize air leaks once it is installed in a home. Special windows

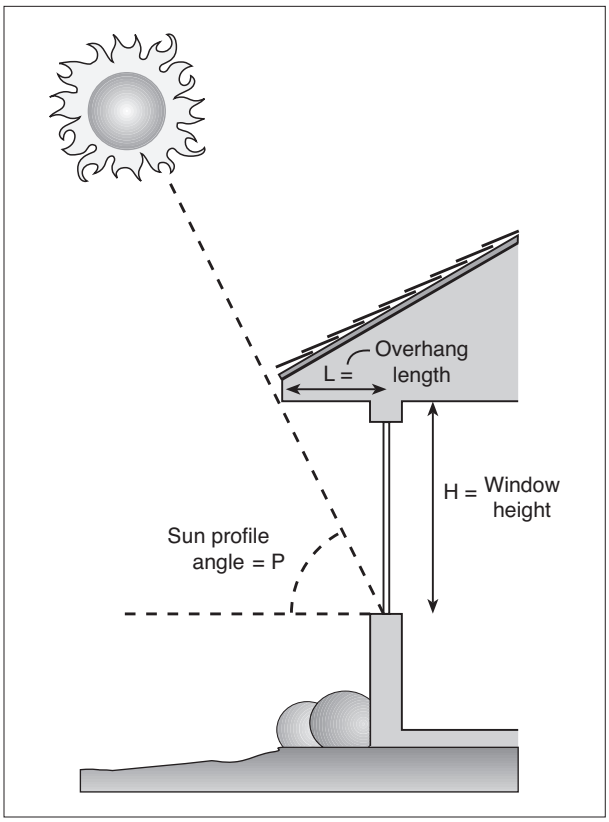


FIG. 2. *Sizing overhang*

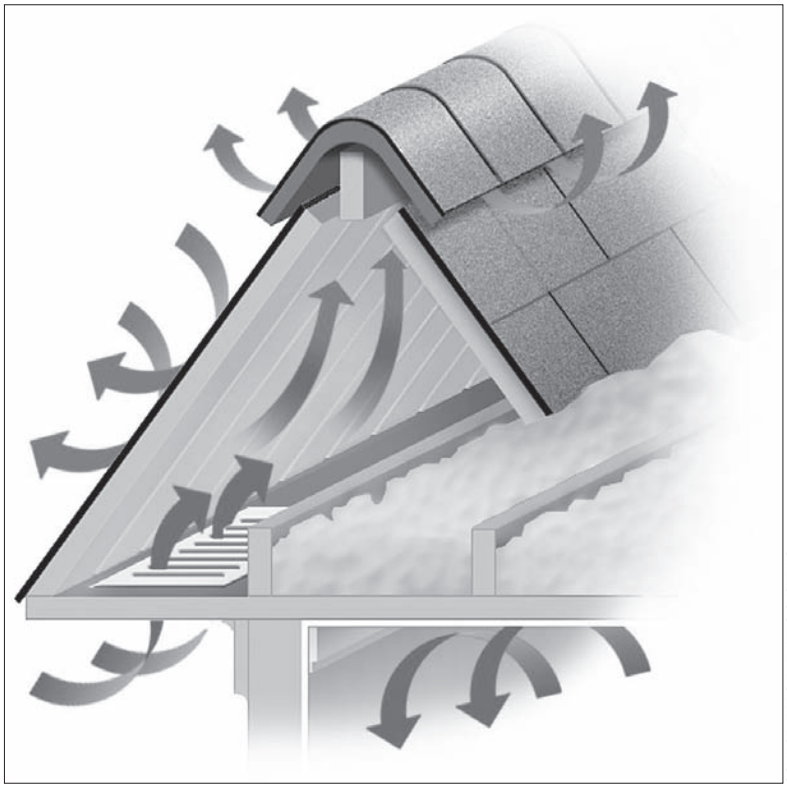
that are designed to prevent heat from entering your home and that meet certain criteria determined by experts are called high-performance windows.

RADIANT BARRIERS

A radiant barrier can be anything that is very reflective, such as aluminum or other metallic foil, special paint or special roof shingles. Radiant barriers are usually applied under the roof because roofs get the most exposure to direct sunlight. However, radiant barriers can also be installed on walls that get lots of sunlight, too. When a radiant barrier is installed under a roof, it reduces the amount of heat from the sun that passes through the roof to the attic space. This minimizes how hot an attic can become on a hot, sunny day. By reducing the heat in your attic, the amount of heat in your home is minimized, too. When installed correctly and with proper insulation, a radiant barrier can reduce heat transfer through your ceiling up to 25 percent.

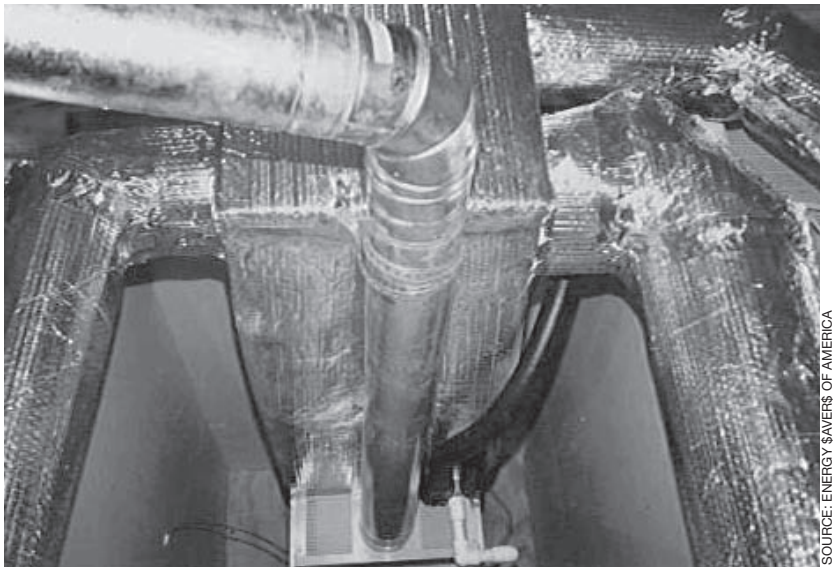
SOLAR SHADING

On south-facing walls, properly designed roof overhangs are an effective means to keep out sun in the summer while allowing it to enter the home in the winter. Overhangs can shade a home's windows, doors or walls. (See Fig. 2) On east and west walls, solar screens are more effective. Solar screens look like standard window screens except they prevent direct sunlight from entering the window. When solar screens are installed, they are able to block up to 70 percent of the sunlight that would otherwise go into a building. By blocking the



SOURCE: EFFICIENT ATTIC SYSTEMS

ATTIC RADIANT BARRIER *A shiny barrier attached under the attic roof reflects light and prevents heat from entering the home.*



SOURCE: ENERGY $AVER$ OF AMERICA

ATTIC DUCT SYSTEM *Insulating and sealing ducts can be one of the most cost effective ways to save energy.*

sunlight with solar screens, the heat generated by the sunlight does not enter the home.

ENERGY EFFICIENT APPLIANCES

Next to heating and cooling a house, home appliances use the largest amounts of energy every day. Appliances, particularly refrigerators, consume a great deal of energy over their lifetimes. By selecting energy-efficient appliances, homeowners can dramatically reduce home energy costs. Air conditioners, refrigerators and washing machines are examples of appliances that can reduce home energy bills when efficient models are chosen. Of course, higher efficiency appliances are initially more expensive than less efficient models, but they can quickly pay for themselves. Remember refrigerators last 15 to 20 years, air conditioners about 10 to 12 years, so you will pay to operate the appliance every month for the next 10 to 20 years.

Heating and cooling often account for 45 percent of the average homeowner's annual utility bill. So an investment in high efficiency heating and cooling equipment may be the best move a homeowner can take.

Other investments in things like compact fluorescent light bulbs reduce energy usage. Compact fluorescent light bulbs use a fraction of the electricity used by incandescent bulbs while providing the same amount of light. Finally, install ceiling fans. A ceiling fan makes you feel cooler, and its effect is equal to lowering the temperature by about 4 degrees F. Just be sure to turn it off when you are not in the room.

ATTIC VENTILATION

Texas attics need to have proper ventilation, particularly in the summer. Proper ventilation will help prevent the attic from getting hot and will avoid moisture build-up. The most effective attic ventilation occurs when air is allowed to enter under the soffits and exit at or near the ridge. (See Fig. 3)

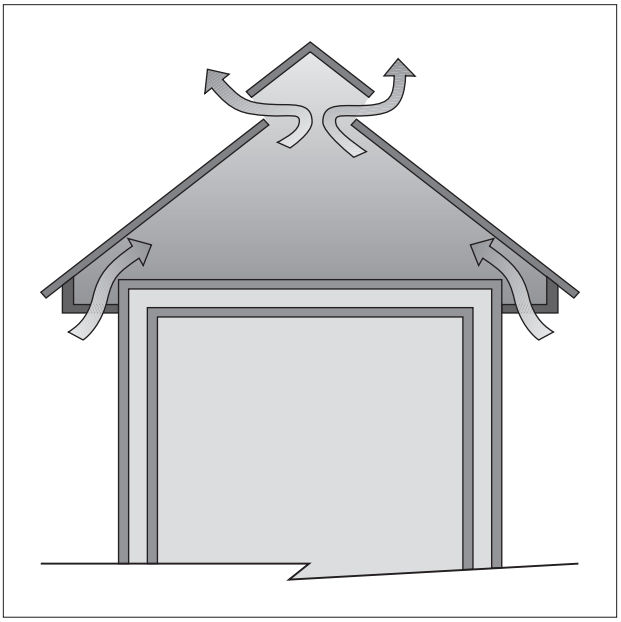


FIG. 3. *Ridge and soffit vents*

STUDENT DATA SHEET

Understanding the Reading Passage

1. Explain this sentence in your own words. "Saving energy is far easier and often cheaper than producing it."

   _____

   _____

2. Why is it important to have insulation in a home? _____

   _____

3. What is the purpose of sealing around electrical wires and plumbing found in a home? _____

   _____

   _____

4. Name three types of barriers and how they are able to help reduce sun-generated heat from entering the home.

   1 _____

   2 _____

   3 _____

5. What are energy efficient appliances? _____

   _____

6. List two ways that a properly ventilated attic helps reduce solar heat gain?

   1 _____

   2 _____

Vocabulary

Based on the Reading Passage, write down your understanding of these words or word pairs and verify your definitions in a dictionary, on the Internet if available or with your teacher:

caulk _____

conductor _____

duct _____

heat _____

insulation _____

radiant barrier _____

radiation _____

R-value _____

U-value _____

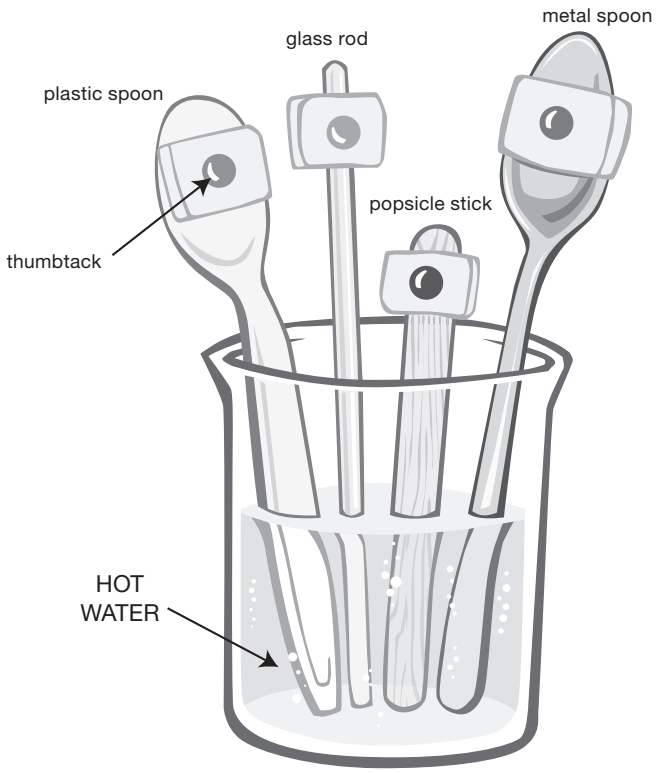
Lab Activity – Testing Materials for Conducting Heat

Introduction
The purpose of this activity is to determine which materials act as better insulators. Insulation plays an important role in conserving energy in your home.

Before You Start
Review the vocabulary words from the Reading Passage. Ask your teacher if you are unsure of any of the meanings. Divide up all the steps in the Lab Activity first, so that everyone has a clear job to do.

Materials
Obtain an equipment kit from your teacher. Check that it contains the following materials:
- 2 spoons (one plastic, one metal)
- 1 popsicle stick
- 1 glass stirring rod
- 500 ml beaker
- 500 ml hot water >85°C
- timer or stop watch
- 1 plastic knife
- 1 ea. 1/4 inch square slice of saturated margarine or butter (in stick form), very cold or frozen
- goggles
- 4 thumbtacks
- 1 small piece of wax paper

Performing the Activity (wear goggles)
1. Collect the plastic spoon, the metal spoon, the popsicle stick, and the glass stirring rod and lay them side-by-side.
2. Take the 1/4 inch square of butter and lay it flat on a small piece of wax paper.
3. Take the plastic knife and cut the butter square into quarters (4 equal parts).
4. Put one piece of butter on each of the following:
   a) the end of the plastic spoon
   b) the end of the metal spoon
   c) the end of the popsicle stick
   d) the end of the glass stirring rod
5. Place the 2 spoons, the popsicle stick, and the glass rod (all with their piece of butter) into the beaker and position them so the butter is placed beyond the rim (outside of) the beaker.
6. Place a thumbtack into the center of each of the 4 pieces of butter.
7. Obtain 500 ml of hot water, as the teacher directs, and carefully pour the hot water into the beaker, with the spoons, stirring rod, etc. **DO NOT DISTURB THE BUTTER AND THUMBTACKS WHILE POURING THE WATER**.
8. Start the timer. Measure the time in total seconds that it takes for each thumbtack to fall from its spoon, popsicle stick and stirring rod. Record the time for each thumbtack in Data Table 1 of your Lab Report Form. You must record 4 readings in the table.
9. After the thumbtacks have fallen off, touch the 4 materials and rate how they feel from the coolest to the hottest.
10. Make a graph showing the difference in melting time for the 4 materials (glass, plastic, metal, and wood).



Lab Report Form

Date _____

Purpose of this lab is to _____

_____

Instructions:
Follow the directions in the Lab Activity to set up your experiment, record your observations in the data table and answer the data analysis questions below.

DATA TABLE 1. Melting Time of Selected Materials

Item	Time In Seconds	Observations
popsicle stick		
glass stirring rod		
plastic spoon		
metal spoon		

Data Summary

1. From which item did the thumbtack fall first? _____ second? _____ third? _____ fourth? _____

2. What is the range of melting times you recorded? _____

3. What is the average time for your data results? _____

4. Based on your observations, which item is the best insulator? _____

5. Based on your observations, which item is the best conductor of heat? _____

STUDENT DATA SHEET

Assessment Questions

1. What was the method of heat transfer from the water to the butter? _____

2. What are some materials used to reduce air leaks in your home? _____

3. How is an attic ventilated without mechanical equipment? _____

Multiple Choice Questions

1. How much of an electric bill is from heating and cooling a home?
   a) 12%
   b) 17%
   c) 45%
   d) 85%

2. To save energy and money, a simple step is to add:
   a) caulking
   b) insulation
   c) both a and b
   d) an additional air conditioner

3. The easiest place to add extra insulation in an existing home is:
   a) a wall
   b) baseboard
   c) window frame
   d) attic

4. To save energy during the summer, adding _____ is an easy solution.
   a) a furnace
   b) solar screens
   c) a toaster
   d) a water heater

5. A radiant barrier, which prevents heat from entering your home through the attic, is made from:
   a) copper
   b) putty
   c) reflective aluminum
   d) foam

6. High efficiency appliances:
   a) cost more to buy
   b) cost less to operate
   c) reduce energy use
   d) all answers a, b, and c

7. A roof overhang:
   a) shades out summer sun
   b) shades out winter sun
   c) lets sunlight in during winter
   d) a and c

8. The best R-value is
   a) R = 35
   b) R = 5
   c) R = 12
   d) R = 20

9. When you own a home you will:
   a) use insulation
   b) use efficient appliances
   c) use caulking
   d) all answers a, b, and c

TEACHER ANSWER KEY

Understanding the Reading Passage

1. Accept students' answers. When considering all the resources that are necessary to generate energy including the extracting or capturing the raw materials or fuel source, labor, transportation, etc. (whether it is from a fossil fuel or a renewable energy source), simple steps like turning off lights when not used or selecting appliances that use less energy require far fewer resources. When a home is properly insulated, the amount of energy needed to heat and cool the house is less, so the cost of energy used is less as well.
2. A properly insulated home helps reduce the need for energy to heat and cool a house.
3. Properly installed sealing of open places helps limit the amount of air losses from inside the home as well as prevents air from outside entering.
4. High performance windows, radiant barriers and solar screens are able to limit solar heat from entering a home through trapping the heat in air, reflecting away from the house or not allowing the sun-generated heat to enter the house.
5. Energy efficient appliances are newer technologies for home appliances that use lower amounts of energy to operate.
6. Attics need to have air ventilation to prevent moisture build-up and reduce heat gains.

Lab Activity Data Summary

1. answers will vary
2. Range is the difference between the highest number of seconds and the lowest number of seconds among the four readings.
3. The average is the total of all the seconds divided by 4.
5. answers will vary
6. metal

Assessment Questions

1. conduction
2. caulk, foam, fiberglass
3. continuous ridge and soffit vents around the roof

Multiple Choice Questions

1 c; 2 c; 3 d; 4 b; 5 c; 6 d; 7 d; 8 a; 9 d

Vocabulary Definitions

caulk – a semi solid, clay like material that can be squeezed into cracks to stop air leaks

conductor – a material that allows electricity or heat to pass through it

duct – pipe, tube or channel that conveys a substance (such as air throughout a building)

heat – form of energy arising from the random motion of molecules and capable of transmission by conduction, convection, or radiation

insulation – the material, stuffing or padding used so that heat, sound or electricity cannot pass through it

radiant barrier – a shiny barrier, attached under an attic roof for example, that reflects light rays, thereby preventing the attic air space from being unnecessarily heated

radiation – passage of energy through open space, like sunlight

R-value – numerical scale for insulation value, with lower numbers being poorer insulators than higher numbers; typical ranges are R-9 through R-30s

U-value – amount of heat transferred through a material; the lower the U-value, the slower the rate of heat flow and the better the insulating quality

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