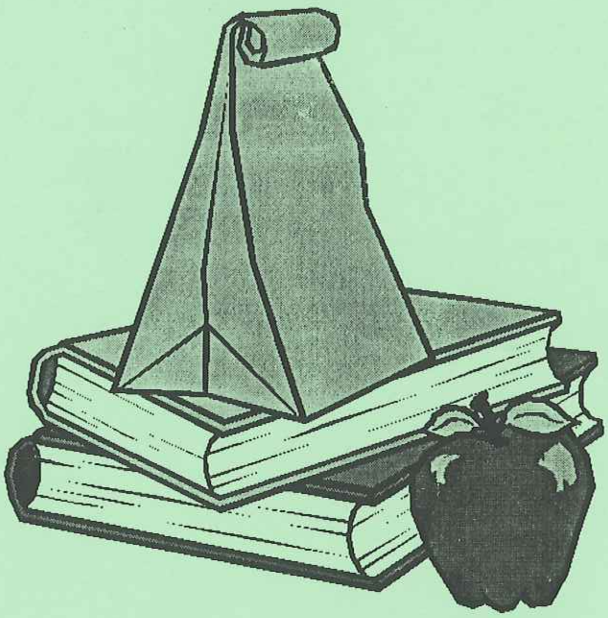
Energy Education Resources for Middle Schools



A Compilation of Lesson Plans and Activities for Grades 6-8

By Jennifer Rubsamen, Stephen Layton, and Steve Watkins

Dear Educator,

This packet contains a selection of energy education related lesson plans for the 6-8 grade levels. The packet was compiled by three HSU students as their environmental science senior project.

The lesson plans in this packet are a representation of the large variety of curriculum available to teachers interested in bring energy education into the classroom. There are many more energy education resources available to middle school teachers beyond what is contained in this packet. A listing of additional online resources for teachers interested in pursuing this exciting topic further appears at the end of this booklet.

We hope that you and your students will find these lesson plans helpful and stimulating. Energy awareness begins while we are young – today's students are tomorrow's energy consumers and decision makers. By incorporating energy education into schools today we can all look forward to a brighter future.

Best wishes in your energy education pursuits!

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Acid Rain

Lesson plan also available online at: http://www.ase.org/educators/lessons/acid.pdf

Objectives:

The student will do the following:

1. Observe and explain a demonstration of the reaction of acid precipitation on limestone and granite materials.
2. Predict the possible effects of acid precipitation in our natural environment.

Subjects: Ecology/Environmental Science, Earth Science, Physical Science, General Science, Chemistry

Time: 1 class period (plus optional exercise)

Materials:

· crushed limestone (enough to fill a 2-liter container; available at garden supply)
· crushed granite (enough to fill a 2-liter container; available at garden supply)
· (2) 3-liter soda bottles or 1-gallon plastic containers
· 1-gallon plastic bottle
· (2) clear 1-pint collecting containers
· sulfuric acid
· pH indicator solution
· distilled water
· water test kit or pH meter
· optional student sheet (see http://www.ase.org/educators/lessons/acid.pdf)

Background Information

Normal rainfall is slightly acidic (pH 5.6, where 7.0 is neutral) because of reactions with atmospheric carbon dioxide which form carbonic acid. Rainfall with a pH of less than 5.6 is referred to as acid rain. Acid precipitation contains sulfuric and nitric acids. The sources of these acids are both natural and man-made. Acid rain is produced naturally through geothermal emissions and biological processes, but our heavy use of fossil fuels is the most significant contributor by far. Emissions from automobiles and other vehicles and from utilities and industries are the chief sources of acid-forming sulfur and nitrogen oxides. These compounds react with water to form acids. These acids reach the ground in rain and snow, finding their way into surface and groundwater systems. Sometimes the particles of oxidized material fall directly to the earth in dry form and combine with surface water to produce acids.

Acid deposition is a problem in much of the United States (U.S.), but the degree to which an area suffers from it varies according to the total acidity deposited and the area's sensitivity to that acidity. One factor in sensitivity is the geology of a particular area. In areas where the bedrock is limestone, acid precipitation can be neutralized to some degree by acid-base reactions; limestone's buffering action lessens its impact. In mountainous areas, the bedrock is usually granite, which does not neutralize acid. In such areas, acid rain enters surface and groundwater systems virtually unneutralized, causing the acidity of these systems to increase and affecting sensitive plants and animals.

Procedure

I. Prepare a demonstration of the reaction of acid precipitation with limestone and granite.

A. Cut off the bottoms of two clean 3-liter soda bottles (or 1-gallon plastic milk containers). Turn them upside down and support them so that they are stable. (These will be filled with rocks, so strong supports are needed.) Place about two liters of crushed granite in one container and the same amount of crushed limestone in the other. Place a 1-pint collecting container beneath the neck of each bottle.

B. Prepare simulated acid rain.

1. Distill one gallon of tap water (or purchase a gallon of distilled water) and pour it into the clean container. Determine its pH (using a water test kit or pH meter).

2. Carefully mix sulfuric acid into the distilled water to achieve a pH of 4.3 to 4.5. This will approximate the average range of acidities of rainfall in the Tennessee Valley.

II. Share the background information for this activity with the students.

III. Demonstrate the effects of the two rock materials on the pH of the simulated rainfall.

A. Place pH indicator solution in both collecting containers.

B. Slowly pour one-half of the "acid rain" solution into each container of crushed rock. Observe as the solution infiltrates the crushed rock and as the leachate flows into the collection containers.

C. Using the same means of determining pH as was used above, determine the acidity of the liquid in each collecting container.

D. Have the students record the data using a table like the following:

pH of acid rain ________

pH of water after passing through the granite ________

pH of water after passing through the limestone ________

IV. Discuss the demonstration with the students. Make sure they understand what they have observed.

A. Ask if there was a color change in the collection containers. If so, have the students explain this observation.

B. The non-neutralized and the neutralized "acid rain" solutions were different colors, indicating different acidities resulting from contact with the rocks.

C. Ask if there was a significant pH change in either container. If so, why do they think this has occurred?

The pH values obtained from the indicator chart show that there is a difference. Remember also that pH values are logarithmic, not linear, values and that a change from 5 to 6 means a power of 10 difference. A change from 5 to 7 means a power of 100 difference. The limestone neutralized some of the acid, but the granite did not.

V. You may want to have your students research the chemical formulae of limestone and the components of granite. This may enable some students to write the chemical equations for the neutralizing reaction and to see why the granite has no buffering action.

VI. Continue with the follow-up below.

Follow-Up

I. Ask the students how acidic precipitation could affect water quality.

Even a slight change in pH of an aquatic habitat can have a significant effect on the small organisms which form the basis of aquatic food chains. In this way, wildlife can be greatly affected. Additionally, a pH change can change the normal concentrations of nutrients and other chemicals in the water. This too can have significant impacts on wildlife.

II. Ask the students to compare (from their knowledge and experiences) general trends in acid precipitation in the U.S. and abroad. Are they aware of the results of eastern and midwestern industrialization on the eastern U.S. and Canada? Can they explain the role of prevailing winds? Are they aware that Europe's problems with acid rain are worse than ours?

III. Extension

A. What are the major sources of acid precipitation? Exactly how is it transmitted? Have the students contact the National Oceanographic and Atmospheric Administration (NOAA) for information on acid precipitation monitoring in the U.S. and in Canada. What do the students believe to be the best approach for reducing or eliminating acid rain?

B. Collect some local bedrock samples for use in the above activity. Repeat the demonstration to determine if your local bedrock is an acid neutralizer. Regions with limestone rock have a natural ability to neutralize acid rain or other acidity and so are not generally affected as much as some other areas. On the other hand, regions with mostly granite rocks tend to be more sensitive to increases in the acidity of the environment.

C. Using the student sheet "SOILS OF THE TENNESSEE VALLEY" (see http://www.ase.org/educators/lessons/acid.pdf), have the students predict the effects of acid rain on areas within the Valley region. Which area(s) is (are) most susceptible? They will need to look up more information on the soils, particularly the soils' parent materials (i.e. the bedrocks from which the soils were formed). This serves as an excellent introduction to the field of soil science.

Cost Effective Buying

Lesson plan also available online at: http://www.ase.org/educators/lessons/buying.pdf

Subject: Social Science Physical Science
Time: Two three-class periods.
Materials: Student worksheet (provided on page 7)
Objective:
To learn how to evaluate energy-related purchases in terms of cost- effectiveness; i.e., time to "payback," "rate of return on investment".
Method:
Teacher will explain the concepts to the students. The students will then practice buy/nobuy sample problems on the student worksheet provided. Teacher may also wish to enhance the experience by inviting a salesperson of energy-related products to speak to the class. The teacher should also discuss other criteria which motivate people to buy; e.g. impulse buying, perceived benefits.
Skills:
Student will learn how to estimate cost-effectiveness and get a better perspective of the sales process.

Background

When we feel impelled to buy a more fashionable garment or an avocational device (e.g. a stereo, a VCR, a boat) we do so with satisfaction in the knowledge that the purchase will enrich our lives. We buy labor-saving appliances because they will minimize our work and give us more time for other activities (e.g. leisure).

Consider the motivational factors for purchasing an "energy-saving" heating or cooling system. One might name "convenience," "dependability," "good servicing support," "brand name," "low first cost," "low cost to operate," and "estimated future energy/money savings," as factors influencing the decision to purchase. That last factor, "estimated "future energy/money savings", reflects the consumer's awareness of the rising cost of energy and his or her determination to reduce energy bills, save money, and as a result, save energy as well.

We expect the heating and cooling system to eventually "pay for itself." We calculate how much time will pass before the monthly savings offset the purchase price. Simple "payback" is the quotient of the total installed cost divided by the first year's dollar savings. If tax credits are available, they should be subtracted from the installed cost. The inverse of simple payback is the first year's "rate of return." An example will help to clarify this:
A high efficiency air-conditioner replaces an older model. It costs $360 installed and is estimated to save you $10 each month it operates or $40 a year. Simple Payback is $360 divided by $40/year or 9 years. Rate of Return for first year is ($40/360) 100 or 11.1%
These cost figures enable us to compare one purchase option against another. A more accurate analysis would take into account factors such as interest, tax, and inflation factors. Interest, for example, is always a factor because, even if we pay cash, we must consider the interest our capital would have earned had it been otherwise invested. Taxes are a factor because the interest we pay on a loan (finance charge) may be an allowable deduction on our income tax return and the interest which we may receive on our capital, otherwise invested, is taxable. Inflation is a factor because it has been with us a long time and because the cost of our conventional energy resources, limited in supply, will rise.

A readily available and inexpensive microcomputer program entitled "Cost Benefit Analysis" is available which makes this more accurate calculation which is called a cost benefit analysis. In the program the "present value" concept is used to take into account the time value of money. That is, savings which will accrue to my account next year in the amount of $100 must be discounted to reflect the amount of money today which, because of interest added, would result in $100 next year. The source of this program is given in the Sources section.

Procedure

1. Energy-saving devices depend on different energy sources: e.g. natural gas, electricity. Students should obtain from home the average cost of energy sources used. For example:

A. Electric bills

C = dollar cost
H = kilowatt-hours used
K = cost per kilowatt-hours (kWh)
C/H = K

B. Natural gas bill (amount used will be in a) therms or b) cubic feet).

a) C = dollar cost
A = amount of therms used
T = cost per therm
C/A = T
b) C = dollar cost
A = amount of 100 cubic feet used (CCF)
F = cost per CCF
C/A = F

Note: If you want to convert these to Btu use the following

1) Kilowatt-hour = 3413 Btu
2) therm = 100,000 Btu
3) CCF = 100 (H.V.) Btu
Where H.V. is the Heating Value in Btu/cubic feet (to obtain the heating value or Btu/cu.ft. of natural gas, contact your gas company.)

2. Student should work sample problems on Student Worksheet provided.

3. (Optional) Obtain the Energy Education Software Series program "Cost Benefit Analysis" from the Energy Division, Alabama Department of Economic and Community Affairs (See Sources). Follow the directions in the program's Teacher's Guide.

Extensions

1. Visit an appliance store and read the energy-rating label and record the expected annual savings and the dollar costs of three refrigerators. Compute the simple pay back and first year rate of return for each of them.
2. Perform Step (1) using energy-rating label data from three air-conditioners.
3. Perform Step (1) using energy-rating label data from three space heaters.
4. Life Cycle costing is a technique for evaluating purchase options. This is done by comparing the total lifetime cost of buying, installing, operating, maintaining, and

salvaging an appliance referenced to the same time value of money. Look up "life cycle costing" and report to the class. What is meant by salvage value? List the factors evaluated in the calculation.
5. Based only on operating costs (e.g. ignoring maintenance cost) determine what the payback would be on a new car of your choice.
6. Have students calculate the Btus for the electric bill and gas bill and discuss factors that explain how they compare to the Btu's of others in the class. (NOTE: Size of home, number in family, direction house is facing, etc.)

New Terms:

- Simple Payback
- Cost Benefit Analysis
- Rate of Return
- Life Cycle Costing

Sources

Energy Education Series Software, "Cost Benefit Analysis" Program, Energy Division, Alabama Department of Economic and Community Affairs, 3465 Norman Bridge Road, Montgomery, Alabama 36105. Contact: Mrs. Donna Robinson 305/284-8937, 1-800-392-8098 toll-free in Alabama.

COST EFFECTIVE BUYING STUDENT WORKSHEET

NAME ________________________________ DATE ____________________

The money you save by replacing a worn-out energy consuming system with a more efficient one adds up and will eventually repay you for making the purchase, if the payback time is less than the system's lifetime. Simple "payback" is computed by dividing the total installed dollar cost by the annual dollar savings. The first year "rate of return" is the inverse of the payback time in percent or may be computed by diving the annual dollar savings by the system's total installed dollar cost.

COMPUTE PAYBACK AND THE PERCENTAGE RATE OF RETURN IN THE FOLLOWING PROBLEMS:

1. You can choose one of the following insulations with the following results:

    Insulation #1 Installed Cost = $200 Annual Savings * = $120

    *Savings from reduced fuel bills due to added insulation.

    Insulation #2 Installed Cost =$235 Annual Savings = $145

Payback:

Insulation #1 = ______ yrs. Insulation #2 = ______ yrs.

Rate of Return on your investment:

Insulation #1 = ______ % Insulation #2 = ______ %

Which one do you choose? ________________________

2. You can choose one of the following water heaters with the following results:

    Water Heater #1 Installed Cost = $325 Annual Savings* = $19

    *Thicker wall insulation in the new water heater.

    Water Heater #2 Installed Cost = $1475 Annual Savings* = $150

    *Solar water heater that only uses purchased energy when not enough solar energy is available

Payback:

Water Heater #1 = ______ Water Heater #2= ______

Rate of Return:

Water Heater #1 = ______ Water Heater #2 = ______

Which one do you choose? ________________________

3. You can choose one of the following room air-conditioners with the following results:

    Air Conditioner #1 Installed Cost = $220 Annual Savings = $15

    Air Conditioner #2 Installed Cost = $435 Annual Savings = $35

Payback:

Air-conditioner #1 = ______ Air-conditioner #2 = ___

Rate of Return:

Air Conditioner #1 = ______ Air Conditioner #2 = ___

Which one will you choose? ________________________

Converting Fuels to Obtain Energy

Lesson plan also available online at: http://www.ase.org/educators/lessons/convert.pdf

Suggested Grade Level: 7-9
Disciplines: Science, Technology, Social Studies
Skill Objectives

- Using references to learn about various fuels
- Using references to obtain information about energy conversion devices

Major Understandings

- Fuel is energy stored in chemical form.
- Various devices are used to transform the energy in fuels into work.
- No energy conversion device is 100% efficient.
- Different devices have different efficiencies.
- The energy that is wasted in a conversion is usually in the form of heat.

Background

Each American has over fifty "workers" performing energy conversion tasks every day, yet most Americans do not realize the energy required to feed these technological helpers. The more complex the society the greater its energy use per individual by these motors, engines, pumps, heaters etc.

Electricity, a commonly used form of energy, is produced by turbines and generators, which are conversion devices. These devices are powered by various sources of energy, such as fossil fuels, hydropower, wind, nuclear, etc. The electricity produced is eventually converted or changed into other end use forms of energy such as heat, light, mechanical energy, and others.

The efficiency of conversion devices is important in obtaining the best change in energy form with the least amount of undesirable "loss" in the form of heat or waste fuel. It is important to use the most efficient and effective conversion technology to do the job and thus conserve our nonrenewable energy supplies.

Advance Planning

- The instructor should do both the fuel worksheet (B) and the conversion device worksheet (C) to anticipate any possible problems in terms of reference materials.
- Collect information on such energy conversion devices as automobiles, motorcycles, mopeds, school buses, etc. Ask students to research and build files on energy conversion devices.
- Assemble dictionaries, pictures, and diagrams of energy conversion devices.
- Reserve the library.

Suggested Time Allotment

One period for introductory discussion and Worksheet A.
Two to three periods for researching the fuel terms and energy conversion devices found on Worksheets B and C.
Two periods for completing Worksheets B and C and discussing questions.

Suggested Approach
Using Worksheet A, introduce the concepts of energy forms; energy use and conversion; energy sources and end uses; renewable and nonrenewable energy sources; energy conversion devices; and efficiency.

Show samples of various fuels.

Allow students to work as partners in doing their research and completing their worksheets.

Precautions
This activity requires research, quality source material, and careful thinking. Be sure to plan for all of the above.

Points For Discussion
Wise consumer use of energy means conserving fossil fuel and improving efficiency. Select an activity that uses energy and discuss the following:

Is this activity really required?
Can it be accomplished more efficiently?
What options are there for accomplishing it?
What is the total cost, including annual maintenance costs, for the different options?

Research, discuss and show examples of conversion loss. If energy cannot be created, where does it come from? If not destroyed, why are we running out of some forms?

Typical Results
Results on the worksheets will reflect the quantity and quality of research each student cared to perform, as well as the adequacy of the reference materials.
Stress accuracy and depth of research and thought.

Evaluation
Give a quiz on the glossary of energy terms.
Evaluate completeness and accuracy of worksheet answers.
Evaluated written answers to questions.

Modifications
- Add other conversion devices to the chart. Examples: solar collector, wind powered electric generator, solar power tower, hydropowered electric generator.
- Contrast renewable and nonrenewable forms of energy on a chart which lists the end uses (such as heat, light, mechanical energy, etc.) of those forms.
- Research one type of conversion in great detail, such as the conversion of electricity to heat.
- Build friction loss devices. Examples: model cars for testing on inclined planes, model boats or airplanes.

Converting Fuels to Obtain Energy: Student Information

Background

When we use energy we often convert it or change it from one form to another. The energy in fossil fuels or other sources of energy is not always in the form we need. The purpose of energy conversion is to change energy resources into more usable forms. Fuel is matter-containing energy stored in chemical form. Food, wood, and coal are all examples of fuels. Energy is packed into the chemical structure of the fuel, and we release it when we convert or change that chemical structure.

For example, food contains Calories, units of energy content. We eat food, and our bodies convert it, releasing energy in the forms of motion and heat. It is actually the energy from our food that allows us to move, and that which keeps our bodies at their normal temperature.

A similar process takes place when we burn other fuels. The chemical energy stored in them is released when they are changed or broken down by some conversion device. For example, we use a conversion device (gasoline engine, diesel engine) to change chemical energy into thermal and mechanical energy, to make a motor vehicle move. What other energy conversion devices can be used to change energy from one form to another? What forms of energy result form these changes (conversions)? Is energy lost in making these conversions?

Objectives

At the completion of this activity, you should be able to

- Identify several fuels
- Describe several uses for the energy obtained from fuels
- Identify devices that convert energy in fuel to some other form of energy, and
- Recognize that some energy is wasted in every fuel conversion process

Skills and Knowledge You Need

Average reading and writing skills
Simple subtraction skills
Ability to find information in dictionaries, encyclopedias, and other references (library skills)

Words You'll Learn

chemical energy
combustion
conversion
conversion efficiency
conversion loss
fuel
fuel cell
mechanical energy
nuclear energy
nuclear fuel
electrical energy

electric generating plant
energy
energy conversion device
fossil fuels
fossil fuel powered electric generating plant
nuclear powered electric generating
plant
photosynthesis
solar cell
solar energy
thermal energy

Materials
copies of Worksheets A, B, and C
reference books

Procedure
1. Your teacher will introduce you to the ideas and terms on Worksheet A.

2. Look at Worksheet B. Use a dictionary, encyclopedia, and other energy reference materials to find the information necessary to complete the worksheet.

3. Look at Worksheet C. Using the reference materials, fill in the blank spaces on the chart.

4. With a partner or in a small group, list other energy conversion devices you can think of at the bottom of Worksheet C. See if you can find the required information about each of these devices to fill in the spaces on the worksheet.

5. Compare worksheets with your partners, and share information. Then see if you can answer the questions below.

Questions
1. Is a "conversion device" the same as a machine? Why or why not?

2. Are you an energy conversion device? Where do you get your energy? What do you convert it to?

3. Does a conversion device transform all the energy in a fuel to another form of energy, or does it waste some? If some energy is loSt, in what form(s) is it lost?

4. Which energy conversion device (from Worksheet C) is most efficient? Which energy conversion device is least efficient?

5. Which energy conversion devices do you yourself use? Which devices do other people operate to do things for you?

6. Are there other fuels that could be added to Worksheet B? Are there substances that are
not used as fuels now that may be used as fuels in the future?

7. What conversion devices can you imagine for the future, that might use fuel more efficiently?

Looking Back

Human beings depend on fuels. We use many kinds of energy conversion devices to get the energy from fuels and transform it into useful work.

There are two problems with using fuels. First, the supplies of some fuels are limited. If we use them up, they are gone for good. Oil, coal, and natural gas are like that, and are called nonrenewable for that reason. The second problem with using fuels is that when we convert them to obtain usable forms of energy we always waste some of the fuel. No conversion device is 100% efficient, not even the human body. Some of the energy in fuels is not converted and remains in chemical form, and some energy is given off as waste heat. This is a problem of efficiency.

As an energy consumer, you should know when you are using nonrenewable fuels. You should also be aware of the efficiency of the conversion devices you use.

Going Further

- Figure out how to improve the efficiencies of some of the conversion devices listed on Worksheet C.
- Use the library to investigate environmental effects of each conversion device listed on Worksheet C.

Worksheet A: A Glossary of Energy Terms

General

Energy - the ability to do work or make things move. Energy exists in a variety of forms (electrical, mechanical, gravitational, light, nuclear, chemical, heat or thermal) and can be converted from one to another. Common units for measuring energy are calories, joules, Btu, and kilowatt-hours.

Forms of Energy

Chemical energy - the energy released when substances combine or break down and form new substances.

Electrical energy - energy in the form of a flow of electrons that can be produced by chemical activity in a battery, by friction, or by generators. Electrical energy can be transformed to other forms of energy such as light, heat, mechanical, or sound.

Mechanical energy - energy due to the motion of an object. Example: the energy of the moving parts of an automobile engine.

Nuclear energy - energy from radioactive decay or from fission or fusion reactions. In a controlled situation it can be used to produce electricity.

Thermal energy - heat energy; the energy of moving particles within a solid, liquid, or gas.

Sources of Energy

Fossil fuels - coal, oil, and natural gas; this term applies to any fuels formed from the fossil remains of organic materials (plants and animals) that have been buried for millions of years.

Solar energy - the radiation emitted by the sun. The earth receives this energy mostly in the forms of heat and light.

Nuclear fuel - material containing atoms whose nuclei split or undergo fission, producing heat energy.

Energy Conversion (Transformation)

Conversion - the changing of a substance or the energy in it from one form to another

Photosynthesis - the process by which green plants use solar energy to convert simple substances into complex ones which contain chemical energy. Carbon dioxide and water are combined, in the presence of sunlight and chlorophyll, into carbohydrates such as sugars, starches, and cellulose.

Combustion - the process of burning a fuel to release heat energy

Fuel - any substance that can be burned to produce heat. (With nuclear energy, a substance that undergoes fission in a chain reaction to produce heat.)

Conversion loss - the amount of energy lost in the changing of one form of energy to another form. Much of this energy loss is in the form of waste heat.

Energy conversion device - a machine or object that changes one form of energy to another form.

Conversion efficiency - the percentage of usable energy that is left after an energy conversion. EFFICIENCY = (Energy output / Energy input) x 100

Energy Conversion Devices

Fuel cell - a device that changes the energy in fossil fuels to electricity.

Fossil fuel powered electric generating plant - a building in which electricity is produced by burning fossil fuels to make steam which powers the generator.

Nuclear powered electric generating plant - a building in which electricity is produced by using the heat given off by nuclear fuel in a controlled chain reaction to make steam which powers the generator.

Solar cell - a device that changes sunlight to electricity

Worksheet B: Using Fuel Energy

NAME ______________________________ DATE ____________________

Directions: Find information about the following fuels, and complete this chart.
Energy is often stored in chemical form. Here are two common forms of chemical energy.

	Definition	Example	Use	How Converted for Use
Carbohydrates				
Hydrocarbons				

Matter that has energy stored in it in chemical form is called fuel. Some common fuels are:

	Definition	Example	Use	How Converted for Use
Food				
Wood				
Oil				
Natural Gas				
Coal				

Worksheet C: Converting Fuel Energy

NAME ______________________________ DATE ____________________

Directions: Find information about the following energy conversion devices and complete the chart.

Energy Conversion Device	Fuel Used	Average Conversion Efficiency	Conversion Loss	Forms of Energy Produced in the Conversion Processes
fuel cell	hydrocarbon, hydrogen, etc.	60%	40%	chemical -> electrical
gas furnace		80%		
oil furnace		80%		
wood stove		60%		
fireplace		14%		
diesel engine		38%		
gasoline engine		25%		
fossil fuel powered electric generating plant		40%		
nuclear fuel powered electric generating plant		30%		
solar cell		10%		

Home Energy Audit

Lesson plan also available online at: http://www.ase.org/educators/lessons/audit.pdf

Suggested Grade Level: 7-9
Disciplines: Science, Social Studies, Home Economics, Technology
Skill Objectives:

- Recognizing energy conservation design features in buildings
- Using energy conservation vocabulary
- Making and recording observations
- Conducting a simple energy audit

Major Understandings

- Many buildings are poorly designed from an energy standpoint
- Heat loss takes several forms; conduction, convection, radiation, and air infiltration all contribute to heat loss.
- There are many useful steps that can be taken to reduce building heat loss, increase comfort and save energy and money.

Background

For a nation with a small population (6% of the world's), the United States uses an enormous amount of energy, about a third of the energy produced each year on the planet. As Wilson Clark stated in his book Energy for Survival: the Alternative to Extinction, "it's as if every American citizen had 300 laborers working 24 hours a day for him alone."

Such a situation cannot continue to exist. There are many alternatives, but not all are very attractive. To give ourselves the best chance of maintaining a comfortable standard of living without monopolizing the world's resources, we must develop awareness and habits of conservation. That is what this activity seeks to develop.

The biggest energy consumers in the home are space and water heating. Conservation measures that affect those two factors can make a marked difference in the energy consumption and comfort level of buildings. The owner of an older home or building can save as much as 50% on heating bills by adding insulation and storm windows. Although there is an initial cost, most energy conservation improvements pay for themselves in five years or less. Add to that the energy conservation tax credits that begin to be available when energy supplies are scarce, and you begin to realize that heating a poorly insulated house is like burning money.

Advance Planning

Obtain class sets of brochures on home energy conservation from your local utility.
A supply of tissues, tissue paper, or thin plastic and tape should be made available for students making their draft meters.
Collect samples of insulation, caulk, and weather-stripping, and pictures of these items being installed. Many hardware and building supply stores have free "how-to" pamphlets and samples for prospective customers.
Ask a builder, energy manager, building superintendent, or other person familiar with building materials to talk with the class about the problems of energy conservation in buildings.

Suggested Time Allotment
One class period for discussion of vocabulary
One weekend homework assignment for collecting data
One class period for developing the sheet of recommendations
One class period for discussing and revising the sheet of recommendations

Suggested Approach
Be sure that students are familiar with the vocabulary used in the exercise. Demonstrate making and using the draft meter. Describe the techniques that students will use in making the necessary observations in their homes.
Consider using a set of photographs or a "home-like" classroom such as the home economics suite as a preliminary exercise to give students some initial experience.
If possible, have samples of insulation, caulk, and weather-stripping for students to become familiar with.
Where possible, allow students to make observations in pairs.

Precautions
It is advisable to notify parents of your students in advance if inspection of their homes is planned.
Students who are apartment dwellers should also be provided with a form letter to the landlord or building superintendent, explaining the project.
If a commercial building is to be studied, obtain permission well in advance of the observation.

Points for Discussion
- Why were buildings built for so long without regard for energy conservation? Why are some buildings still being constructed that way?
- Did our ancestors, in colonial times or in other countries, use energy conservation to make their homes more comfortable? Give examples.
- What "Energy Savers" are most important for summer cooling?
- How could convection be used to help with summer cooling?
- What useful energy conservation building features were not covered in this activity?
- Describe the "Energy Efficient House of the Future." How would it be designed, oriented, landscaped, and managed?

Typical Results
Observations will vary depending on upon the design, age, and maintenance of the buildings under examination.
Students should be able to list several methods to conserve energy in homes, based upon their analyses.

Evaluation
Ask students to show you their completed Data Sheets before preparing the recommendations.
Collect and examine the recommendation sheets for appropriateness and feasibility.
Prepare a survey six months subsequent to the activity to identify any improvements made in home energy conservation by your students.

Modifications

While this activity focuses upon residential dwellings, slight modifications of procedures and checklists could make it appropriate for industrial, commercial, or agricultural buildings.

Have students do an energy audit of the school and share the recommendations with the administration or school board.

Home Energy Audit: Student Information

We spend most of our time in buildings -- homes, schools, offices, and stores. But most people hardly notice details about the buildings, such as how they are designed, how they are built, and how well they are maintained. These details have a strong effect on how much we enjoy a building and how much it costs.

An "energy-efficient" building is more comfortable than a wasteful building. It needs less fuel for heat and less electricity for cooling. A building that is badly designed and poorly kept up wastes money. Why? Because it is trying to heat and air-condition the outdoors as well as the indoors.

This activity turns you into an instant BUILDING INSPECTOR. Your assignment: Identify whatever helps or hurts energy conservation in a specific building. You can become a kind of detective looking for "bad guys" that waste energy and money.

Objectives

At the completion of this activity, you should be able to

- identify the major construction, maintenance and design features that make a building energy efficient;
- define and use each of the vocabulary terms discussed in this unit;
- explain energy saving steps to a homeowner.

Skills and Knowledge You Need

Ability to make observations and to record them

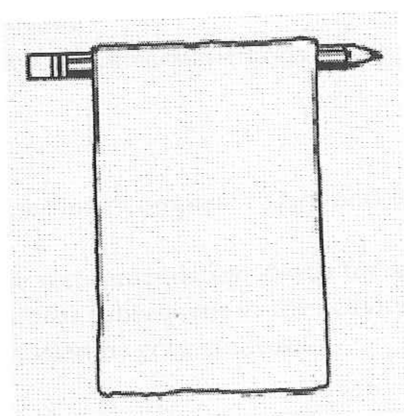
Materials

2 Vocabulary sheets: "Heat Bandits" and "Energy Savers"
2 Energy Audit Data Sheets: Interior and Exterior
Materials to make a draft detector as shown in the diagram: pencil, tape, and tissue paper or thin plastic

Procedure

1. Go over the two vocabulary sheets and discuss them with the rest of the class to be sure you understand each of them.

2. Make a draft detector to use during your energy audit (shown below).



3. Using the Interior and Exterior Data Sheets, complete the observations on your house, apartment, or a building suggested by the teacher. Use the draft detector to help locate air infiltrations.

4. Develop a set of recommendations for improving energy conservation in the house, apartment, or building that was studied. List alternative whenever possible, so that the owner has choices in making conservation improvements.

5. Compare observations with other students in order to improve your study. Revise your improvements sheet based on these discussions.

Questions

1. How many of the items on the Energy Savers list are inexpensive and easy to install?

2. Why are most building lots landscaped the way they are? Do good energy conservation principles generally seem to be used?

3. The locations of most windows in a dwelling are related to the need for light inside and the desire of those designing the home for balance and appeal. What effect would conservation practices have on window locations?

4. For what purposes is hot water really needed in a home? What are the reasons for many people using more hot water than they really need?

5. If a homeowner had only a limited amount of money, what energy savers do you think would help most for the least money?

Looking Back

You have just investigated some features which make a building an energy saver or an energy waster.

Most buildings have many places where heat escapes. Some of these can be easily patched or sealed at little cost. Other features will be more difficult and more expensive to alter. Investing in conservation saves money in the long run, though, and makes our houses, apartments, and workplaces more comfortable. Buildings of today and tomorrow will be constructed with much more energy awareness than there has been in the past.

Going Further

- Take a list of recommendations you developed (Procedure, Step 4), and find out how much they would cost to implement. Take the necessary measurements, and check with a hardware or building supply center to get prices.
- Take photos of good conservation practices and poor conservation practices related to a building that you have studied. Arrange the photos of poor practices next to diagrams that illustrate how they can be eliminated. Photos of good practices could be displayed with captions explaining why they are good.
- In a single color, sketch the landscape around a building that you have observed. Using a contrasting color, sketch in plantings that may improve energy conservation by reducing air infiltration in the winter or providing shade in the summer.

- Design a blueprint or model of a building which incorporates the energy conservation features you have identified.

Vocabulary Sheet: Heat Bandits

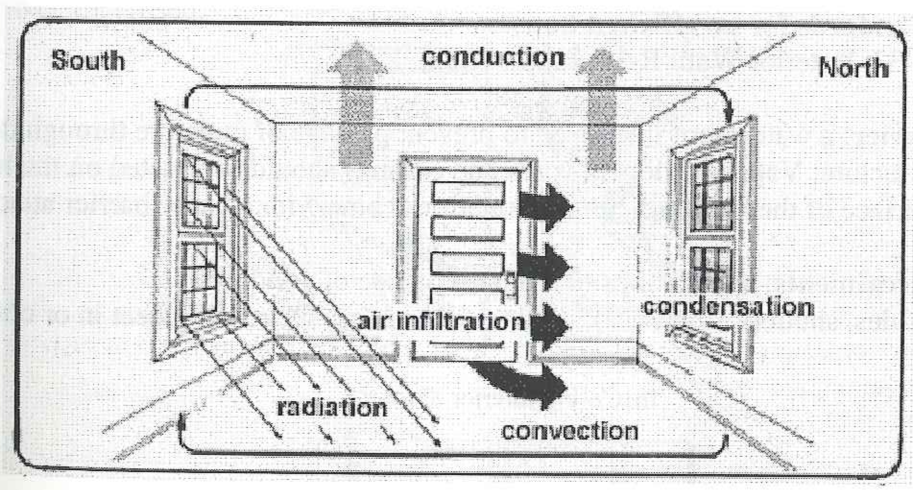
Radiation: passage of energy through open space, like sunlight. During the daytime a building absorbs solar radiation, but after the sun goes down, it starts to reradiate heat to the cold outside air unless something is done to block the radiation.

Conduction: passage of heat through a material. Some materials, like glass and metal, conduct heat (and lose it) easily. Insulation helps to block conduction of heat. If ceilings and walls are poorly insulated, they conduct heat from the house to outside.

Convection: transfer of heat by movement of air. As heated air contact cold surfaces such as windows, it loses heat. The cooled air is denser than warm air, so it tends to settle, pushing warm air toward the ceiling. These temperature changes and air movements form a pattern. Warm, light air from the ceiling area is chilled along the window, becomes heavier and drops to the floor. It moves across the floor, is reheated, moves up the opposite wall, (away from the window), across the ceiling and down past the window again. Each cycle the air loses heat. Heat must be supplied from a sunny window, a furnace, stove, or other heater to maintain a comfortable temperature.

Condensation: beads of moisture that form on surfaces as warm, moist air is cooled. Moisture condensing from room air (showers, breathing, cooking, etc. provide the moisture) shows up most on the cooled areas. Wet or frozen windows are reminders of wasted heat. The cures are double or even triple glazing of windows, heavy drapes, insulating shades, or sliding panels.

Air infiltration: air seepage due to wind. Air pressure pushes cold air in through tiny openings on the windy side and draws heated air out of the opposite side of the house. Drafts occur through wallboard cracks, gaps around paneling (top, bottom, and sides), cutouts for pipes and wiring, poor seals for window sashes, badly weather-stripped doors, and loose molding at bottoms of walls.



Vocabulary Sheet: Energy Savers

Insulation: material with high resistance (R-value) to heat flow. Some commonly used materials for home insulation are fiberglass, cellulose, rock wool, and styrofoam. The resistance to heat flow is provided by the many small dead air spaces between the fibers or particles. Insulation comes in as variety of forms: blankets, or batts, foam, boards, or small loose pieces.

R-value: the factor which tells how much resistance to heat flow a material has. The higher the R-value, the greater the insulating efficiency of the material. R-values are commonly stated per inch of building material. R-values are additive - thicker material or a combination of materials means increased resistance to heat flow.

Approximate R-value per inch of thickness for common insulation materials:

Material "R" per inch thickness

Flexible

Cellulose fiber with vapor barrier 3.20-4.00**

Glass fiber or mineral wool 3.00-3.40**

Loose Fill

Glass fiber and mineral wool 2.80-3.40

Cellulose 3.50-3.70

Vermiculite, expanded 2.13

Rigid Board

Polystyrene, extruded 5.26

Expanded urethane, preformed 5.80-6.25

Glass fiberboard 4.00

Polystyrene, molded beads 3.57

Foamed-in-Place

Expanded urethane, sprayed 6.25

* Determined from ASHRAE Handbook, 1972

** Varies according to density and fiber diameter

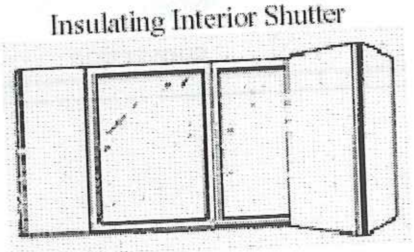
R-value standards for an efficient house:

Ceiling: R-33; Exterior Wall: R-19; Floor: R-22;

Vapor barrier: a waterproof liner used to prevent passage of moisture through the building structure. Vapor barriers in walls and ceilings should be located on the heated (indoor) surface of the building. Some insulations come with a vapor barrier attached.

Window treatments: applications to the interior side of windows (blinds, shades, shutters, draperies), used to save energy by keeping heat in or out.

Insulating Interior Shutter



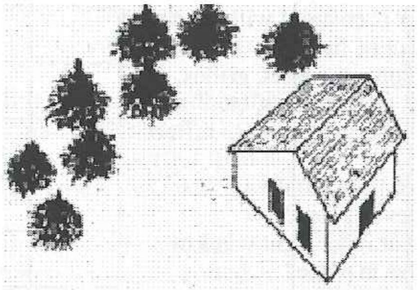
Damper: a trapdoor or other device which controls the passage of air through a duct, chimney, or stovepipe.

Flow restrictor: a device attached to a water nozzle or shower head to reduce the flow of water while maintaining the pressure of the spray. This saves energy by cutting down on the amount of hot water being used.

Clock thermostat: a thermostat equipped with a timer to change temperature levels automatically at certain times of day. It helps to save energy by turning down the heat at night and during the hours when people are usually out of the house.

Roof overhang: a solid horizontal or angled projection on the exterior of a building placed (ideally) so that it shades southern windows in summer only, when the sun is high in the sky. This saves on air-conditioning. (To determine the approximate size overhang needed, add the height of the window to the distance from the top of the window to the overhang, and divide by 2.)

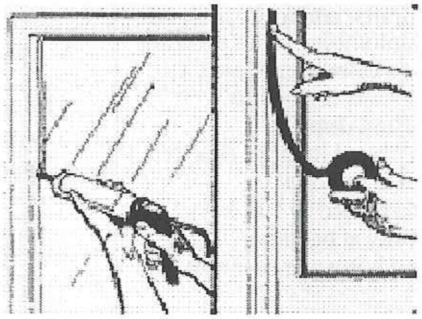
Windbreak: a dense row of trees, or a fence or other barrier that interrupts and changes the local path of the wind. Windbreaks located on the north and west sides of a building can save heat by reducing wind chill and air filtration.



Air lock entry: a porch, vestibule, or entry hall with an inner door and an outer door at the entrance of a house or building. The two doors save energy by cutting down on air exchange when people go in or out.

Caulk: a soft, semi-solid material that can be squeezed into non-movable joints and cracks of a building, thereby reducing the flow of air into and out of the building.

Weather-stripping: material which reduces the rate of air infiltration around doors and windows. It is applied to the frames to form a seal with the moving parts when they are closed.



Home Energy Audit Data

Date________________________

Name ________________________________

Name or location of building inspected: ________________________

Interior =========================	Yes	No	Does Not Apply (Or Comments)
1. Are the ceilings insulated? (In apartments, ask the superintendent or building owner for details.)			
2. How thick is the insulation? (Check with ruler in attic or crawl space. Tell in inches - last column.)			
3. Is there a vapor barrier (plastic, aluminum, or heavy brown paper) on the indoor side of the insulation?			
4. If the building is on a slab or has an unheated basement, does the first floor have insulation under the floors?			
5. If the basement is heated, are the basement walls insulated?			
6. About how much of the floor is covered with rugs, padding, and carpeting? (per cent of fraction)			
7. Are heating and cooling equipment (ducts, grilles, radiators) blocked by furniture, rugs, drapes, etc.?			
8. Are walls and ceilings light enough in color to reflect light well?			
9. Are insulating drapes or other tight window treatments such as framed shades in place?			
10. Are these insulating drapes or other tight window treatments such as framed shades in place?			
11. If there is a fireplace, does it have a damper and glass doors?			
12. Is the damper closed when the fireplace is not in use?			
13. Are the glass doors kept closed during fireplace use to keep warm room air from escaping up the chimney?			
14. Does the draft detector move when placed along edges of doors and windows on calm and windy days?			
15. On windy days does the draft detector show air currents through electrical outl ts placed on outside walls?			
16. Check other openings for drafts, and make a list of drafty openings. EXAMPLES: plumbing pipes entering walls, exhaust fans in kitchen or bathroom while OFF, chimney pipes exiting through walls or ceilings.			
17. Are hot water faucets free from drips?			
18. Have flow-restrictors been placed in pipes connected to showerheads?			
19. Is there a clock thermostat adjusted to "set-back" (lower) temperatures automatically at bedtime?			
20. Check the cellar for exposed hot water or steam pipes. Are they all insulated?			
21. Check cellar or attic for ducts carrying heated air. Are they wrapped with insulation?			
22. Check baseboard-type radiators. Are openings or metal fins inside blocked or filled with dust?			
23. Is the exhaust hose from the clothes dryer detached from its vent and run through a filter to keep warm, damp air inside the house?			
24. Has the furnace been cleaned and serviced in the last year?			

Exterior ======================	Yes	No	Does Not Apply (Or Comments)
1. Are there fewer windows on the north side of the building?			
2. Are the north windows smaller than those on the other sides?			
3. Does the roof on the south side extend out from the house far enough to block summer sun from walls and windows?			
4. Will the roof overhang the lower winter sun to warm south walls and windows?			
5. Are there storm windows in place and tightly sealed? (If large amounts of moisture condense on the inside of windows and freeze on coldest days storm windows are not working properly.)			
6. If there are no storm windows, are there temporary (plastic) barriers installed? (They should create an air space about 3/4 of an inch thick between inner and outer glazings.)			
7. Are evergreen shrubs and trees planted as windbreaks around the north and west sides of the building?			
8. Are deciduous (leaf shedding) trees planted on the south side for summer shade and winter sun?			
9. Does snow melt more quickly on your roof than it does on similar houses nearby? (Indicates need for more ceiling insulation).			
10. Can you see spaces for air leaks between the house and its foundation, broken windows, rotted boards or other sources of cold air leaks into the cellar or crawl space?			
11. Are cellar doors insulated and tight-sealing?			
12. Are attic vents open summer and winter? (Unless the attic is paneled and occupied, vents should be open. Ceiling insulation should keep your house warm, not a sealed attic. Vents from ceilings of rooms below into the attic should be open in summer, but closed and insulated in winter.)			
13. Are cracks and joints around windows, doors, stairways, pipes, and electrical wires caulked?			
14. Is there weather-stripping around the inner and outer doors? Around the windows?			
15. Are cracks in walls and foundations sealed and holes plugged in?			
16. Is there an air lock entry hall, double door, or insulated storm door at each outside entrance?			

The Formation of Fossil Fuels

Lesson plan also available online at: http://www.ase.org/educators/lessons/fossil.pdf

Suggested Grade Level: 6-8
Disciplines: Science, Social Studies, Math, Technology
Skill Objectives:

- Extracting information from reading material
- Measuring accurately and showing information on a scale
- Doing basic division problems

Major Understandings:

Fossil fuels were formed millions of years ago.
Other sources of energy are replaced continuously. They are said to be renewable.
Fossil fuel resources are finite.
Fossil fuels may be used up at some future time. Because they are not replaced during the time span of human history, they are said to be nonrenewable.

Background

The student reading on pages 32-33 of this booklet should provide the necessary background for doing the activity.

The term quad is short for quadrillion, or 10 to the 15th power BTU of energy. It is usually used where very large amounts of energy are quantified and compared. The statistics given on Worksheet E based on estimates from the U.S. Department of Energy and the U.S. Geological Survey. However, you should be aware that estimates of fossil fuel reserves vary widely. The estimates given here are averages, and include undiscovered reserves as well as reserves that are actually known and measured.

Students should be made aware of these uncertainties about reserves. They also need to know that energy use changes form year to year. So their calculations on Worksheet E are only as valid as their assumptions, which are:
a. that the estimates of reserves are correct, and
b. that energy use will remain at the same level as it was in 1985.

Advance Planning

Discuss with the students the concept of the quad as a unit for measuring an amount of energy.
Show the filmstrip "Energy Options: Part I: Knowing Your Options" from the Energy Education Project.
Discuss the various sources of energy.
Discuss with the students the major concepts involved in the formation of coal, oil and natural gas.
The time for the activity can be reduced if the strips of adding machine tape are cut ahead of time.

Suggested Time Allotment

One period for advance discussion and filmstrip
One period for Worksheets A, B, and C
One period for preparing time lines (Worksheet D) and completing questions

One period for calculations (Worksheet E) and follow-up discussion of entire activity

Suggested Approach

1. Carry out the discussions outlined in the "Advance Planning" section.

2. Have students read Worksheet A, and then discuss Worksheet B with the whole group as reinforcement. Let students try to do Worksheet C individually and then compare and discuss answers.

3. Have students make their time lines. It is recommended that each student in the class make one. Use floors and hallways to stretch them out. Tape down the ends or put a book on each end. When they are finished, answer the questions related to the time lines as a group.

4. You may wish to assign the energy use calculations (Worksheet E) for homework. This is slightly higher level work and will require some thought. Students should be given time to think it through. Then have students explain their methodology. Discuss how valid their calculations are, using the questions as a basis.

Precautions

None

Points For Discussion

What do renewable and nonrenewable mean? Is it valid to compare energy sources only on this basis? How else can we compare energy sources?
Why are nonrenewable resources of such concern to us?
What is meant by energy conservation?
In what ways do you and your family try to conserve energy?

Typical Results

The answers to the fill-ins on Worksheet C are as follows:

1. sun
2. sun
3. renewable
4. photovoltaic
5. heat
6. wind
7. hydropower
8. biomass energy
9. coal
10. oil
11. natural gas
12. nonrenewable

The time lines should clearly show the nonrenewables as widely separated from the renewables.
The number of years (Worksheet E) that each fuel will last, based on constant use, is:
coal
oil

natural gas
1,051.4 years
8.5 years
11.5 years

Evaluation

Give a vocabulary quiz on "Words You'll Learn."
Assign an essay in which the students are to:

1. Summarize the concepts of renewable and nonrenewable;
2. Express their ideas about the supplies of nonrenewables and our use of them.

Collect the time lines and give an evaluation of satisfactory or unsatisfactory, based on how accurately each was done.

Modifications

Bar graphs can be constructed of the energy reserves, energy use, and time to depletion. These can be color coded and will graphically show the results of Worksheet E.

The Formation of Fossil Fuels: Student Information

There are many sources of energy in our world. We can get energy from the sun, from wind, and from falling water. We can also get energy from materials that contain stored energy. We call these materials "fuels." One of our most important sources of energy today is fossil fuels.

Fossil fuels take a long time to form. If we go back in geological history, we find that it took millions of years for our fossil fuels to come to be. Because of the time needed to form these fuels, and because the conditions for formation must be just right, most geologists feel that little or no new fossil fuel is being produced. For this reason, we call fossil fuels "nonrenewable."

In this activity, you will learn some things about renewable and nonrenewable sources of energy. You will see, on a chart you will make, why some fuels are called renewable and some nonrenewable. You will investigate how much fossil fuel we have and how much we use.

Objectives

At the completion of this activity, you should be able to

- demonstrate an understanding of renewable vs. nonrenewable sources of energy,
- explain why the supply of fossil fuels is limited, and
- understand basic energy vocabulary.

Skills and Knowledge You Need

- Ability to read and interpret a chart
- Ability to do division problems
- Ability to make measurements using a meter stick

Words You'll Learn

biomass energy
fossil fuels
hydropower
nonrenewable energy
photovoltaic electricity
quad
renewable energy
solar heat
time line

Materials

adding machine tape - 2 meters long
Worksheets A, B, C, D, and E
meter stick
pencil

Procedure

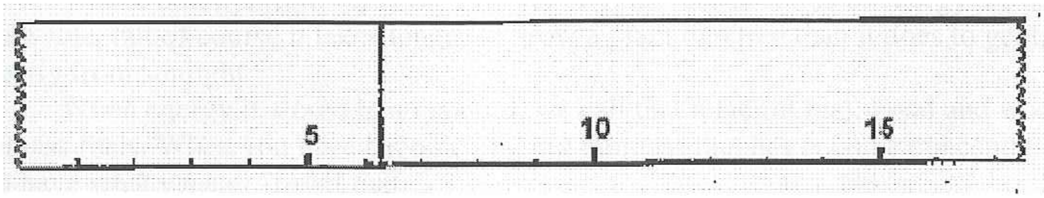
1. Read Worksheet A, and study the diagram on Worksheet B.

2. Make a list of the sources of energy you read about. Make sure that you know what each one is. Your teacher will help you find definitions, if necessary.

3. Study Worksheet C and fill in the blanks, using the information you learned from the diagram.

4. Look at Worksheet D. This is a listing of the times required for energy to be produced from different sources. In order to understand this more clearly, you are going to construct a time line which will show you how these times compare with each other.

5. Place the 2 meter length of adding machine tape flat on a counter or the floor. Using a meter stick, begin at one end of the tape and place marks one centimeter apart for the entire length of the paper. Number every fifth centimeter mark (see sample below).



6. Using Worksheet D, label your time line at the proper place with the name of each source of energy. Place a heavy mark on the time line to indicate the division between renewable and nonrenewable sources of energy.

7. Answer questions on Worksheet D based on the energy production time line you have made.

8. Study the tables on Worksheet E. Then use the information supplied in the table to calculate how long U.S. fossil fuel reserves will last. Answer the questions on the worksheet based on your calculations.

Looking Back

This activity has led you through a series of steps. You learned the names of some sources of energy. You found out that some sources of energy are renewable and some are nonrenewable. Then you calculated how long we can expect our fossil fuel supplies to last.

Fossil fuels are considered to be nonrenewable. There is a definite amount of each one on our earth and in time they will be used up. They are not being produced naturally, and if they were it would take such long periods of time to produce them that only people far in the distant future would benefit.

Perhaps you can think of ways to conserve these precious fuels.

Going Further

- Find out how much a quad of energy is. Estimate how many quads of energy are used in your school each year.
- Make a list of ways you and your family might conserve fossil fuels.
- Assume that the use of each fuel will increase by 10% in the year 1990, and will continue at that level. Calculate the number of years each fuel will last.

Worksheet A: Energy and Time

Name ________________________________ Date_______________________

Energy is all around us, and comes from many sources. One of the most important sources of energy is the sun. The energy of the sun is the original source of most of the energy found on earth.

We get solar heat energy from the sun, and sunlight can also be used to produce electricity from solar (photovoltaic) cells. The sun heats the earth's surface and the air above it, causing wind. Water evaporated by the sun forms clouds and rain to give us flowing streams and rivers. Both wind and flowing water (hydropower) are sources of energy.

So you see, the sun is the source of many kinds of energy found in nature. These kinds of energy are all around us all the time. They are produced quickly, and replace themselves constantly as we use them. For this reason we say they are renewable.
The sun's energy can also be stored. Plants store energy from the sun as they grow. Fruits, vegetables, and wood from trees, for example, all contain stored solar energy. We call it biomass energy, from "bio" for "life" or "living." These kinds of energy are also renewable, but of course it takes longer to grow a plant or a tree than it does to get heat directly from sunlight.

When energy is stored in a material, we call that material fuel. Food and wood are biomass fuels. When you have become old, old biomass that has become concentrated, you have what we call "fossil fuel."

The Formation of Fossil Fuels

Fossil fuels are found deposited in rock formations. They were formed between 350 million and 50 million years ago. The processes by which they formed are not totally understood. Decayed remains of ancient plants and/or animals were buried by sediments. Through the action of heat and pressure over millions of centuries, they were chemically changed. Coal, oil, and natural gas are the results.

Coal was formed from the remains of ferns, trees, and grasses that grew in great swamps 345 million years ago. These remains formed layers as they sank under the water of the swamps. The plant material partially decayed as these layers formed beds of peat, a soft brown substance that is up to 30% carbon. Peat is the earliest stage of coal formation. Shallow seas later covered the swamps and slowly deposited layers of sand and mud over the peat. These sediments exerted pressure on the peat over thousands of years. Slowly chemical changes took place transforming it to lignite or brown coal, which is about 40% carbon. Millions of years later, increasing pressure and heat changed the lignite into bituminous or soft coal (about 66% carbon) and finally into anthracite or hard coal (over 90% carbon).

Worksheet A: Energy and Time
(continued)

Oil and natural gas are also found in beds of sedimentary rock. The sediments were deposited by shallow seas millions of years ago. The remains of plants and animals living in the seas settled to the bottom and were buried under layers of sediment. These layers were subjected to heat and pressure over millions of years. The sediments were transformed into beds of rock, and the plant and animal remains underwent slow chemical change and formed oil and natural gas.

As you can see, the fossil fuels take millions of years to form. They cannot be replaced quickly. In fact, in terms of our lifetime they cannot be replaced at all. For that reason we call them nonrenewable.

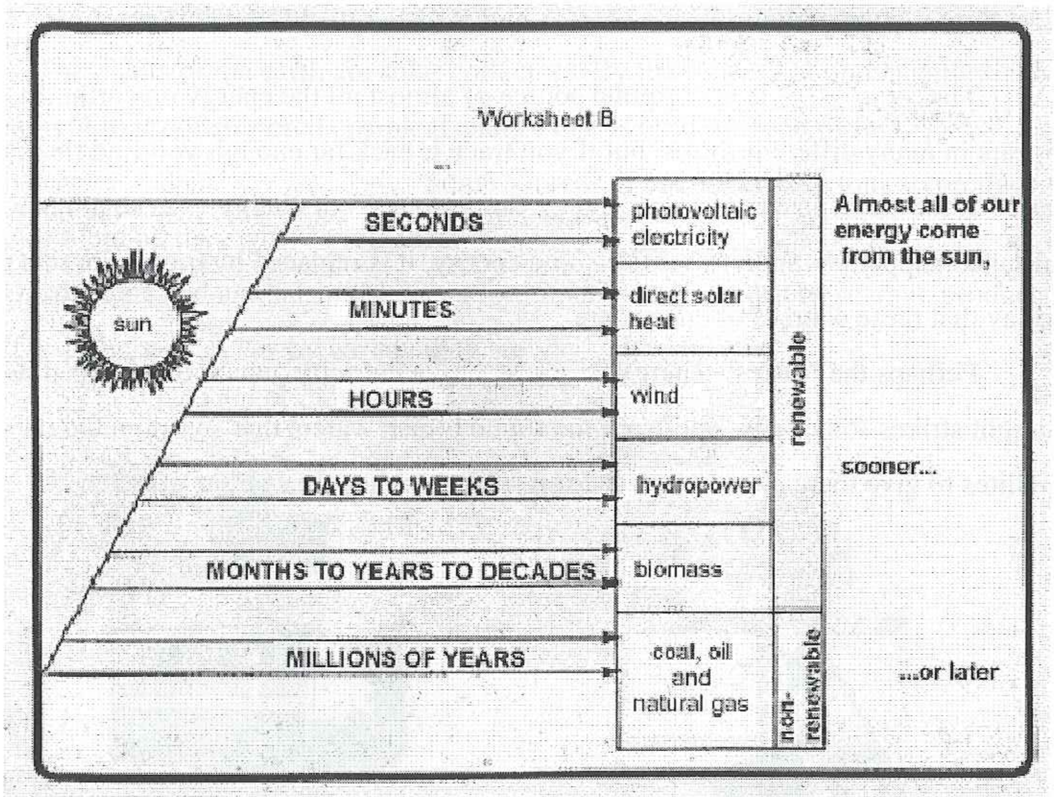
Renewable or Nonrenewable

There are still other kinds of energy: ocean thermal energy, geothermal energy, and nuclear energy, for example. We cannot discuss all of them here, but your teacher can give you information about them.

Are they renewable or nonrenewable? You can decide for yourself. If a source of energy is replaced as we use it, so that we can never use it up, it is called renewable. This is an important idea, because it helps us decide how we should use each of our many sources of energy.

Worksheet B: Energy: Sooner ... or Later

Name ________________________________ Date______________________



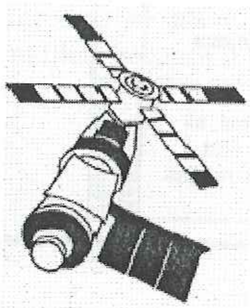
Worksheet C: Understanding Sources of Energy

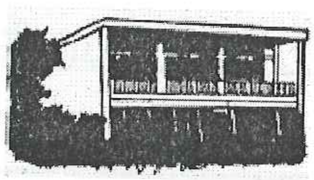
Name ________________________________ Date______________________

Directions: After studying Worksheets A and B, fill in the blanks below.

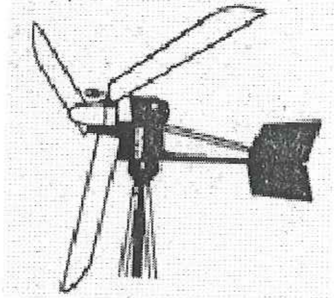
The _________ is the original source of almost all the energy on earth. Energy appears in many different forms, but if you trace it back far enough you find that it all started at the same place: the _________. Some sources of energy exist in almost unlimited supply. As soon as we use some energy, it is replaced by more. For this reason, we say that these sources of energy are _________.

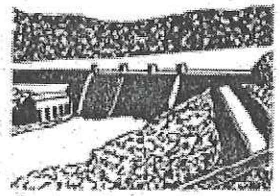
Perhaps the "fastest" energy is _________ electricity, which is produced when sunlight strikes solar cells. These are the round bluish wafers that are mounted on space satellites to give them electric power from sunlight when they are in space.





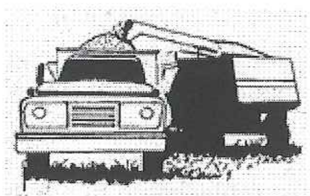
It only takes the sun a few minutes to give us direct solar _________. You can feel it in a car that sits in the sun. Houses and buildings can be designed to collect sunlight the same way. You can also build solar collectors to trap the sun's heat. The sun heats the earth and the earth warms the air above it. Heated air rises (just like a hot air balloon). When cooler air rushes in to displace the heated air we have __________. This energy can be used to sail ships or drive machines to pump water or produce electricity.

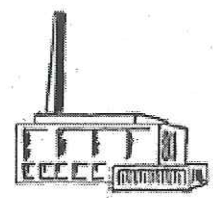




The sun heats the surface water of lakes and oceans. Some of the water evaporates when it is heated. Then it forms clouds, falls as rain, and collects in lakes and rivers. As this water flows back to the sea it provides _________ which can drive a turbine to generate electricity.

The plants of the earth are solar collectors. By the process of photosynthesis they use sunlight to produce stored chemical energy that is used for food or fuel.
Plant energy is called ___________. Some sources of energy take so long to produce that if we use them up they can't be replaced. _________, _________, and _________ are like that. Dead plants and animals must decay for hundreds to millions of years to produce these fossil fuels. That is why we say they are _____________.





Worksheet D: Making an Energy Time Line

Name ________________________________ Date________________________

Directions: Using the chart below, follow Procedure steps 4-6 to construct your time line.

Sources of Energy	Production Time	Position on Time Line
photovoltaic electricity	seconds	1 cm
direct solar heat	minutes	2 cm
wind	hours	3 cm
hydropower	days and weeks	4 cm
biomass	months, years, or decades	5 cm
coal, oil, natural gas	millions of years	200 cm

Questions

1. Some sources of energy are said to be renewable, that is, replaceable in a reasonable period of time. Other sources of energy are said to be nonrenewable because their replacement would take a very long time.
Which sources of energy, on your time line, are renewable and which do you think are nonrenewable?

2. Which sources of energy, on your time line, are most commonly used?

3. Can you think of any problems related to the most commonly used fuels?

Worksheet E:
Fossil Fuel Reserves - How Long Will They Last?

Name ________________________________ Date______________________

TABLE 1 Estimated U.S. Reserves -1985	
coal	18,400 quads
oil	263 quads
natural gas	205 quads

TABLE 2 U.S. Energy Use - 1985	
coal	17.5 quads
oil	30.9 quads
natural gas	17.8 quads

Note: The numbers after each type of fuel are given in units called quads. The quad is a unit which expresses a very large amount of energy. For example, a whole city might use one quad of energy in a year.

Directions: Using the tables above, calculate how many years each fuel will last. Assume that the United States will consume the same amount of fuel every year until it runs out.

Source of Energy	Calculation	Number of Years
	18,400.00/17.5 = number of years U.S. coal reserves will last at the 1985 rate of use	
Oil		
Natural Gas		

Questions (based on your calculations)

1. Which fuel will last longer? Shortest?

2. What is the problem with doing this type of calculation? To be sure that your answer is correct, what other things would you have to be sure of?

The Electric Hookup

Lesson plan also available online at: http://www.ase.org/educators/lessons/hookup.pdf

Objectives:

The student will do the following:

1. Determine the wattage of various household appliances.
2. Calculate the number of kilowatt-hours used by appliances.
3. Identify the need to limit the use of appliances to conserve energy.
4. Identify costs per kilowatt-hour (kWh) of appliances.

Subjects: General Science, Physical Science

Time:

3 class periods (over 2 weeks)

Materials:

student sheets (included)

Background Information

A list of all the energy-using appliances and equipment in an average American home would show why it is estimated that a well-equipped home consumes as much as 35,000,000 British thermal units (BTU) of energy each year to operate. Considering that much of this energy is wasted, a great opportunity for energy conservation exists.

The first step toward conservation is to gain a better understanding of the energy consumption of each appliance or piece of equipment. An appliance's wattage is an indicator of how much electricity is used while operating the appliance. An appliance requiring 1,000 watts would use one kilowatt-hour of electricity during one hour of operation. For example, the average mixer uses 127 watts. This 127 watts divided by 1000 watts/kilowatt-hour of operation equals 0.127 kilowatt-hour. If the mixer is used for 6 minutes, 0.0127 kilowatt-hour of electricity has been used.

Procedure

1. Introduce the activity by sharing with the class the information in the background section above.

2. Distribute the student sheet "Wattage Ratings," included. Have the students bring in wattage ratings from various appliances around their homes. Ask each student to choose appliances that use different amounts of energy and that produce different kinds of energy from the electricity they use (e.g., heat, sound, or motion). Caution the students not to move large appliances by themselves to obtain wattage ratings. Have them seek permission and aid from parents to locate wattage rating information. (Check the owner's manuals before moving appliances.) Use appliances in the school as examples. Students may be assigned different equipment to ensure a wide range and thorough investigation of household appliances. Student sheet answers (in terms of kilowatt-hours of energy required) may be expanded to annual use by determining daily or weekly use and multiplying. If you prefer, use the student sheet "APPLIANCE ENERGY USE," included.

3. Distribute the student sheet "HOW TO READ YOUR METER," included.
   A. Tell the students to record daily meter readings at home for two weeks, and then to bring in an old utility bill along with the data they will have accumulated.

B. Review the information recorded on their utility bills. Then, have each student calculate the charge per kilowatt-hour by dividing the energy charge by the number of kilowatt-hours used in his/her home for that month's bill. (Be sure to use only the energy charge; do not include other fees the utility may assess.) Typical residential rates in Humboldt County average $0.12-$0.14 per kWh.
C. Have each student relate the amount spent on one month's electric bill to something that is pertinent to his/her own life. For example, students may relate the electric bill to car payments, the cost of music tapes, stereo equipment, schoolbooks, or athletic shoes. Solicit several examples from the class.

4. After completing the activities on the student sheets, distribute the student sheet "MAKING CHOICES" included. Are the students willing to change their habits and attitudes, and possibly their lifestyles, to conserve energy?

5. Continue with the follow-up below.

Follow-up
1. Discuss the negative feelings the students may have about conserving electrical energy. What are the negative aspects of conservation? (By now, the benefits should be obvious-saving money and resources.) Conservation often takes self-discipline, development of routine habits, imposing rules upon oneself, lifestyle changes, and changes in purchasing patterns.
Oftentimes these things are not fun or easy for people to accept. What ways can the students think of to motivate themselves and others to conserve?

2. Discuss some practical ways in which students can improve energy conservation in their own homes. Ask, "In what area is your family conserving energy best?" (for example, turning off lights). Ask, "In what area is your family not conserving energy well?" (for example, leaving the TV on while no one is watching). Are any of the students' families involved in serious energy conservation efforts such as the use of solar water heaters, automatic timers on heating/cooling systems, high-efficiency appliances and/or lighting, or other innovative conservation methods? Can the students recommend effective conservation practices to their classmates?

WATTAGE RATINGS

Name ________________________________ Date________________________

Check four different appliances for their wattage ratings. Using the conversion to kilowatt hours (kWh) calculate the electricity usage for each appliance.

Appliance 1: ____________________________

_______watts/1000 watts/kWh per hour of operation = _______ kWh

Appliance 2: ____________________________

_______watts/1000 watts/kWh per hour of operation = _______ kWh

Appliance 3: ____________________________

_______watts/1000 watts/kWh per hour of operation = _______ kWh

Appliance 4: ____________________________

_______watts/1000 watts/kWh per hour of operation = _______ kWh

ELECTRICAL APPLIANCE ENERGY TABLE

Appliance Wattage Rating	Kilowatt-hours of Electricity Used per Hour	Ounces of Oil Burned per Hour	Ounces of Coal Burned per Hour
10	0.01	0.01	0.13
25	0.025	0.025	0.33
40	0.04	0.4	0.5
60	0.06	0.6	0.8
100	0.1	1	1.33
150	0.15	1.5	2
200	0.2	2	2.66
300	0.3	3	4
500	0.5	5	6.66
750	0.75	7.5	10
1000	1	10	13.33
1500	1.5	15	20
2000	2	20	26.66
5000	5	50	66.66
10000	10	100	133.33

APPLIANCE ENERGY USE

Name ______________________________ Date______________________

Think about burning ten 100-watt light bulbs for one hour. That's the amount of electricity equivalent to one kilowatt-hour. Just as you pay for gallons of gas, quarts of milk, and loaves of bread, you pay for kilowatt-hours of electricity.

The chart below shows the average number of kilowatt-hours of electricity that various appliances use.* If you are interested in how much it costs to operate one of these appliances for a month or a year contact your local utilities company.

	Average kWh Used Anually	Average kWh Used Monthly
Kitchen Appliances		
Range w/self-cleaning oven	1224	102
Range w/oven	1152	96
Microwave oven	300	25
Frying pan	190	16
Coffee maker	110	9
Toaster	40	3
Mixer	10	1
Food disposer	30	3
Dishwasher	1560**	130
Refrigerator/freezer 16-25 cu ft side-by-side model, automatic defrost	2160	180
Refrigerator/freezer 14 cu ft automatic defrost	1800	150
Refrigerator/freezer 14 cu ft manual defrost	1200	100
Refrigerator/freezer 17 cu ft, 2-door, high efficiency, automatic defrost	1200	100
Freezer, 15 cu ft automatic defrost	1200	150
Freezer, 15 cu ft manual defrost	1800	100
Laundry Appliances		
Clothes dryer	1000	83
Clothes washer	624**	52
Hand iron	150	13
Other Appliances		
Quick recovery water heater	5400***	450
Vacuum cleaner	50	4
Clock	18	2
Toothbrush	0.5	0.04

Entertainment Appliances	Average kWh Used Annually	Average kWh Used Monthly
Color TV	660	55
Tube Type	440	37
Solid State	440	37
B&W TV		
Tube Type	350	29
Solid State	120	10
Radio/phonograph	110	9
Comfort Appliances		
Electric furnace	13200*****	(Seasonal)
Heat pump	66000****	(Seasonal)
Air conditioner, Central, per ton	1500*****	(Seasonal)
Air conditioner, Room, one ton	1500	(Seasonal)
Dehumidifier	400	33
Electric Blanket	150	(Seasonal)
Attic fan	300	(Seasonal)
Ceiling fan	130	(Seasonal)

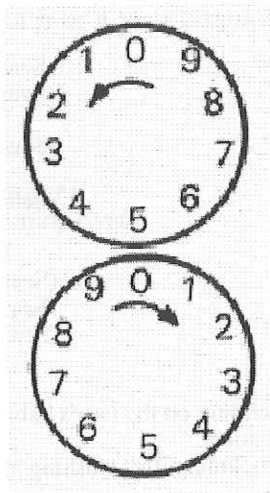
* These figures are averages and will vary depending on the user's habits and lifestyle
** Includes kWh for heating water used by appliance.
*** This value accounts for all hot water usage, including dish washing and clothes washing.
**** Heat only.
***** Based on 1,500 sq. ft house insulated to meet TVA standards for energy efficiency. If your house does not meet these standards it may use considerable more electricity during the heating and cooling seasons.

HOW TO READ YOUR METER

Name ______________________________ Date______________________

In order to read an electric meter you must read from left to right. You must also determine which way the hands are turning on each dial.

Example:

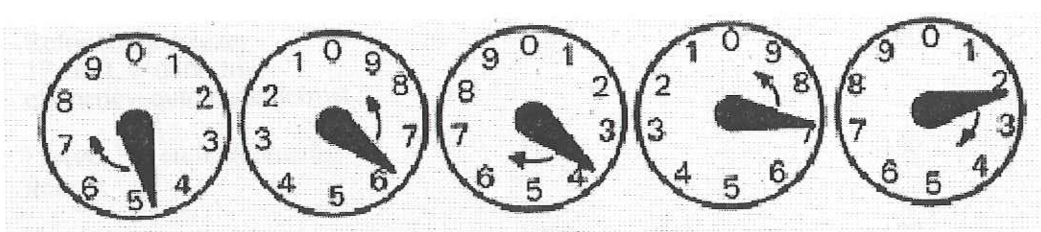


The 1 is to the left side of the dial. This would indicate the hand is turning counter-clockwise.

Here the 1 is the right side of the dial, indicating the hands turns clockwise.

Write down the number each hand has passed. This may not be the number nearest the hand. For instance, if the hand has passed the 4 and is almost to the 5, you still read it as 4. Write down the numbers in the same order as you read the dials from left to right.

In the example given, the reading is 46372. If the last reading was 45109, subtract 45109 from 46372. This will give you the number of kWh used.



That is all there is to reading a meter, with one exception. If a hand points straight at a number and you do not know if it has passed the number or not, then look at the dial to the right. Has its hand passed zero?

To analyze your family's electricity use, read your meter daily for about two weeks, at approximately the same time each day. Record the readings on the following table.

Daily Use of Electricity in My Home

Name ______________________________ Date______________________

Date	Time	Reading	KWh Used Daily	Cost (kWh x $0.12)
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				

MAKING CHOICES

Name ______________________________ Date______________________

Pretend that the government has announced that, because of an energy crisis, electricity will be rationed. According to a new regulation, homeowners will be permitted to own and use no more than 12 electrical items other than lighting and heating/air conditioning systems.

Listed below are a variety of items, which use electricity and are often found in American homes. Choose the 12 items you feel would be most essential to you and rank them from 1 to 12 (1 being the most important, 12 the least). Be prepared to defend your choices.

_____ Television
_____ Automatic coffeepot
_____ Dishwasher
_____ Blender
_____ Electric mixer
_____ Electric shaver
_____ Electric clock
_____ Curlers/curling iron
_____ Electric typewriter
_____ Microwave oven
_____ Telephone answering machine
_____ Electric blanket
_____ Garbage disposal
_____ Refrigerator
_____ Washer/dryer
_____ Food processor
_____ Electric knife
_____ Toaster

_____ Electric can opener
_____ Makeup mirror
_____ Waffle iron
_____ Vacuum cleaner
_____ Fan
_____ Sewing machine
_____ Water heater
_____ Stereo
_____ Electric stove
_____ Toaster oven
_____ Freezer
_____ Computer
_____ VCR
_____ Iron
_____ Griddle
_____ Crock pot
_____ Power tools
_____ Hair dryer

Insulation: Keeping Heat In or Out

Lesson plan also available online at: http://www.ase.org/educators/lessons/insulate.pdf

Suggested Grade Levels: 6-9
Disciplines: Science, Physical Science, Technology
Skill Objectives:

- Recording temperature data at equal time intervals
- Graphing data and interpreting heating and cooling curves
- Drawing inferences from graphed data
- Applying results to everyday situations

Major Understandings

- The best insulation against heat loss is that which allows the smallest change in the interior temperature of a container when the container is exposed to a cooler external environment.
- The best insulation against heat gain is that which allows the smallest change in the interior temperature of a container when the container is exposed to a constant source of heat energy.
- Some materials are good insulators against both heat gain and heat loss and thus are good insulation materials in home construction.
- Because of the diffuse nature of solar energy, insulation is needed in a solar collector to trap and concentrate heat energy.
- Adequate home insulation for keeping heat in during cold weather and heat out during hot weather is an important factor in conserving energy and decreasing fuel costs.

Background

Insulation is any material used to slow heat transfer. The important component of most good insulators is stationary air because air is a poor conductor of heat. Most insulation contains millions of tiny air spaces which slow heat conduction through it. Thus the heat is "kept in" or "kept out," as this activity demonstrates.

Insulation is rated for its resistance to heat flow. This resistance is known as the insulation's R-value. The greater an insulation's R-value, the greater is its resistance. Some sample R-values are listed in the table.

Home insulation is intended to serve two purposes. In winter the insulation should keep heat in, while in summer it should keep heat out. Virtually all insulations slow heat transfer through the material in both directions since this is just a result of poor heat conduction through those tiny air spaces. However, foils are often added to commercial insulations to gain an additional energy-saving factor: the reflection of heat energy, either back into the living spaces in winter, or back to the outside in summer.

Table A24
Typical R-Values of Different Forms of Insulation

	R/inch	Inches Needed For R11	R19	R22	R34	R38	R49
Loose Fill							
Fiberglass	2.25	5	8.5	10	15.5	17	22
Mineral Wool	3.125	3.5	6	7	11	12.5	16
Cellulose	3.7	3	5.5	6	9.5	10.5	13.5
Vermiculite	2.1	5.5	9	10.5	16.5	18	23.5
Batts or Blankets							
Fiberglass	3.14	3.5	6	7	11	12.5	16
Mineral Wool	3.14	3.5	6	7	11	12.5	16
Rigid Board							
Polystyrene beadboard (expanded)	3.6	3	5.5	6.5	9.5	10.5	14
Extruded polystyrene	4-5.41	3-2	5-3.5	5.5-4	8.5-6.5	9.5-7	12.5-9
Urethane	6.2	2	3	3.5	5.5	6.5	8
Fiberglass	4.0	3	5	5.5	8.5	9.5	12.5

Adequate insulation of homes and buildings is an important factor in energy conservation and reduced energy costs. We could save one-third of our current total U.S. energy use through improved design of new buildings and retro-fitting of old ones. A good portion of this saving would come from improved insulation. And just think of the savings in dollars.

Insulation is an extremely important factor in a solar collector, too. Without insulation to trap the heat collected, a solar collector could never attain the temperatures necessary to provide domestic hot water or space heating.

Advance Planning

- Begin collecting soda cans and insulations several weeks ahead. Students can help by bringing cans and scrap insulation from home. Home centers, lumber yards, or insulation contractors may provide you with insulation contractors may provide you with insulation samples or scrap. The home economics teacher may be able to provide wool scraps.
- Attach the lamps to the ringstands so that the light will strike the cans on the tops and sides.
- Be careful to keep the lamps from shining directly in students' eyes. The best set-up is to place the lamps low to the table so that students stand above them.
- Make preparations to provide 50 C water. Often a hot plate and an old coffee pot works best.
- You may want to cut scrap insulations to size before the activity. Students can help with this task outside of class time.

Suggested Time Allotment
Two class periods to set up and perform the activity
One class period to graph data and compare and discuss results

Suggested Approach
1.Students can work in groups of three. One can be the timer, and the other two can read and record the temperatures.

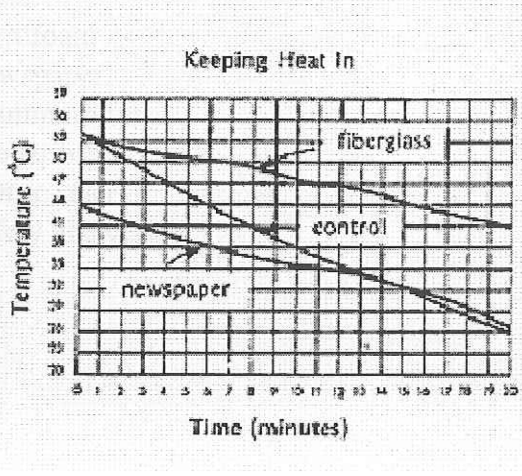
2. After the students have collected and interpreted their data, discuss the importance of insulation in home energy conservation and in solar collectors. If necessary, give students help with graphing, labeling lines, and drawing general conclusions from the graphs.

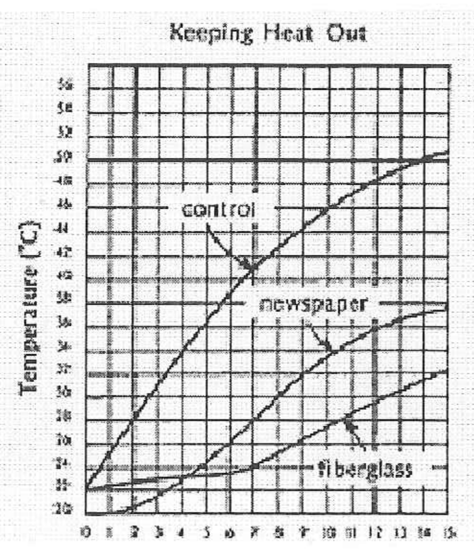
3. If there are not enough lamps for several small groups of students, perform this activity in conjunction with other solar activities. Rotate groups from activity to activity over the course of several days.

Precautions
- *Students should not look directly at the lamps. Remind them to stand behind the lamps as they collect data.*
- *Students should wear safety glasses and gloves when handling fiberglass insulation.*
- *If the water is hotter than 50 C, consider pouring it into the cans yourself. Provide students with mitts or gloves to handle hot glassware and cans.*
- *Do not use shiny cans as the control cans. In Part 2 they will reflect too much heat. You should spray all the cans with flat black paint, including the control set-up can.*

Points for Discussion
- How rapidly did the control can lose heat in comparison to your insulated cans? Gain heat? Why?
- Which insulation slowed heat flow the least? The most? Of the materials tested by your class, which would you recommend as the best home insulation? Why?
- How might you use insulation in active and passive solar heating and cooling?
- By what processes does heat flow from one object to another or to the surrounding air?

Typical Results
The following graphs represent sample results obtained using newspaper and fiberglass as insulations.





Evaluation

- Inspect students' data tables and graphs for accuracy, clarity, and attention to detail.
- Review students' answers to the questions to determine if they have made supportable inferences from the data collected.
- Ask students to explain why insulation is important in a solar collector.
- Request students to discuss in writing one application of their findings too home energy conservation. Inspect their work to see if the suggestion is logical and conforms with the data from this activity.
- The two graphs on this page indicate that newspaper excels compared to the control at "Keeping Heat In" and "Keeping Heat Out" even when the set-up having newspaper insulation begins at a lower temperature.

Modifications

Although this activity is designed to use low-cost metal-backed thermometers, short laboratory thermometers can be substituted.

This activity could also be performed using the sun as a source of energy.

Insulation: Keeping Heat In or Out – Student Information

Many parts of the country experience large changes in temperature from season to season. But human comfort demands a fairly constant temperature in homes and work places throughout the year. In cold weather, this means preventing the escape of heat to the outdoors. In hot weather, it means blocking the invasion of heat from the outdoors. Insulation helps maintain human comfort by blocking heat flow. Some materials are more effective insulators that others. The best insulating material for the home will be one which keeps the most heat in during cold weather and the most heat out during hot weather.

Solar energy collectors also must contain insulation to prevent the collected heat from flowing back into the atmosphere. Hot water tanks and pipes need insulation, too, so that the water they contain doesn't lose its heat.

Objectives

At the completion of this activity, you should be able to

· compare different insulating materials for their abilities to keep heat in and to keep heat out,

· determine the best material for insulating against heat loss and against heat gain,

· explain why insulation is an important part of a solar energy collector, and

· explain the importance of insulating homes to reduce heat loss from the inside in cold weather and heat gain from the outside in hot weather.

Skills and Knowledge You Need

Reading a thermometer

Recording and graphing data

Materials

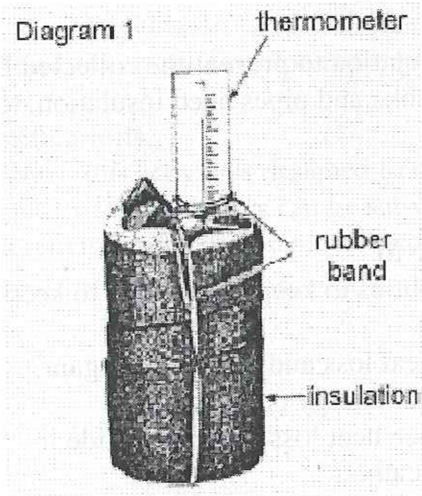
- three identical soda cans
- three Celsius thermometers
- a clock, watch, or timer to measure minutes
- a 200-watt incandescent lamp or flood lamp (with reflector and mounted on a ringstand)
- hot water (50 C)
- insulating materials:
- fiberglass
- wool
- styrofoam
- newspaper
- aluminum foil
- rubber bands
- metric ruler
- safety glasses

Procedure

Part 1: Keeping Heat In

1. Fill the three soda cans to within 1 cm of the top with the hot water.

2. Obtain two of the insulating materials. Carefully and completely wrap one can with one insulation and a second can with the other. Make sure you wrap the can tops, but leave a small hole above the pop-top opening for the thermometer. (See Diagram 1) Hold the insulation in place with rubber bands.



Caution: Do not spill any water on the insulation when wrapping the cans. If you choose fiberglass as the insulation, wear safety glasses and gloves when handling it.

3. Leave the third can unwrapped.

4. Wrap rubber bands around the tops of the three thermometers. Insert the thermometers through the insulation and pop-top opening into the cans. Adjust the rubber bands so that the thermometers are at equal depths (about halfway) in the cans and do not touch any part of the cans.

5. Label the first two columns of Data Table 1 with the kinds of insulation you are using.

6. Read and record in Data Table 1 the temperature of the water in each can.

7. Continue to record the water temperature in each can every minute for 20 minutes.

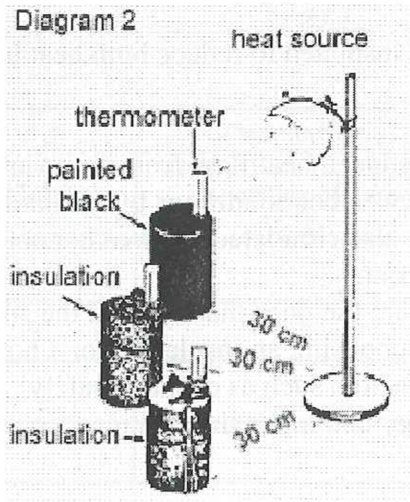
8. On Graph 1, plot your data for each can. Be sure to label each line.

Part 2: Keeping Heat Out

9. Remove the thermometers and insulation and empty the cans.

10.Replace the same insulation and the thermometers. Position them just as you did in Part 1.

11. Place each can the same distance (about 30 cm) from the heat source (the lamp), as shown in Diagram 2.



12. Label the first two columns of Data Table 2 in the same way as you labeled Data Table 1.

13. Read and record in Data Table 2 the temperature of each can.

14. Turn on the heat source. Record the temperature in each can every minute for 15 minutes.
Caution: Do not look directly at the lamp. Read the thermometers from behind the lamp.

15. Turn off the heat source. On Graph 2, plot your data for each can. Be sure to label each line.

Questions

1. What general conclusions can you draw from the graphs?

2. What was the total change in temperature for each can in Part 1? In Part 2?

3. Why did you use the third can in this activity?

4. Of the materials you tested, which was better at keeping heat in? How do you know?

5. Which material was better at keeping heat out? How do you know?

6. Was the same material the better insulator in both cases?

7. Compare your results with those obtained by the rest of the class. Which material would best insulate against heat loss (keep the heat in)?

8. Which material would best insulate against heat gain (keep the heat out)?

9. Based on your results, why do you think insulation is an important part of a solar energy collector?

10. Why should a house be insulated to reduce both heat loss and heat gain?

Looking Back

A good insulation reduced heat flow from warm areas to cold areas. In this activity you simulated cold weather conditions by insulating cans filled with hot water to try to keep the heat in. You also simulated hot weather conditions by insulating empty cans to try to keep the heat out.

The best insulation are the ones that allowed the smallest temperature change inside the insulated can. In choosing an insulation for a house or a solar collector, you would also consider other factors such as cost and safety. Insulation makes an important contribution to saving energy and maintaining human comfort.

Going Further

- Repeat the activity using other sources of heat energy, including the sun. Compare these results to your original results and explain any differences.
- Find out the R-values of the insulation you tested. Write a paragraph explaining R-values, and then compare your results in this activity to the R-values of the insulation you tested. Do they agree? Why or why not? (Refer to transparency A24.)
- Visit a lumber yard and insulation contractor to find out as much as you can about insulation. Gather information on R-values and costs, then recommend an insulation based on these factors.
- Find out the kind, amount, and location of insulation in your home. Determine its R-value. Find out the recommended R-values for walls, ceilings, floors, and basements in your area of the country. If you find your home is not adequately insulated, develop a list of recommendations for improving its insulation. (Refer to transparency A25.)
- Research how homes are kept cool in summer. List as many ways to prevent heat gain as you can.
- Hold a "cool cube" contest. Design a container that will keep an ice cube from melting for the longest time. Which container wins? Why? (The best containers may hold ice for as long as 15 hours!)

Data Table 1: Keeping Heat In

Name ______________________________ Date______________________

	Temperature (°C)		
Time (minutes)	First Can Temperature (Insulating Material: ____________)	Second Can Temperature (Insulating Material: ____________)	Third Can (No Insulating Material)
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

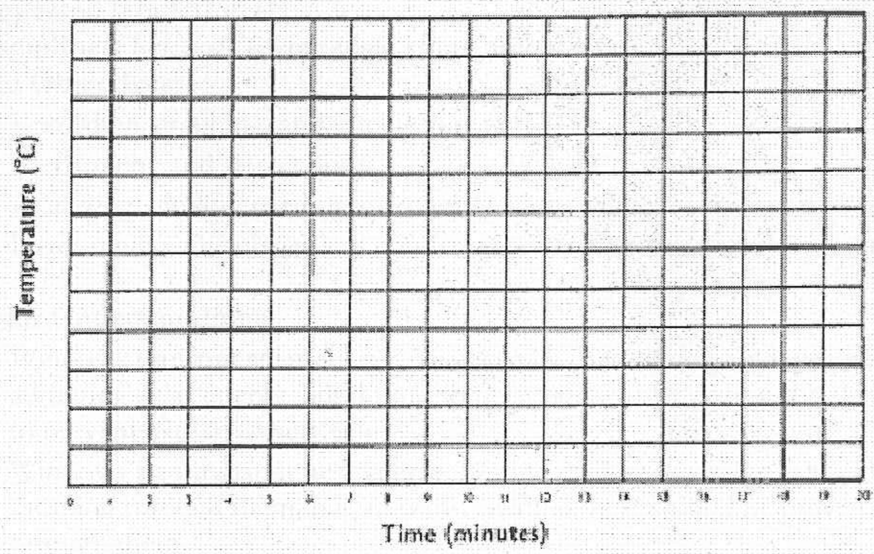
Data Table 2: Keeping Heat Out

Name ______________________________ Date______________________

	Temperature (°C)		
Time (minutes)	First Can Temperature (Insulating Material: ____________)	Second Can Temperature (Insulating Material: ____________)	Third Can (No Insulating Material)
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

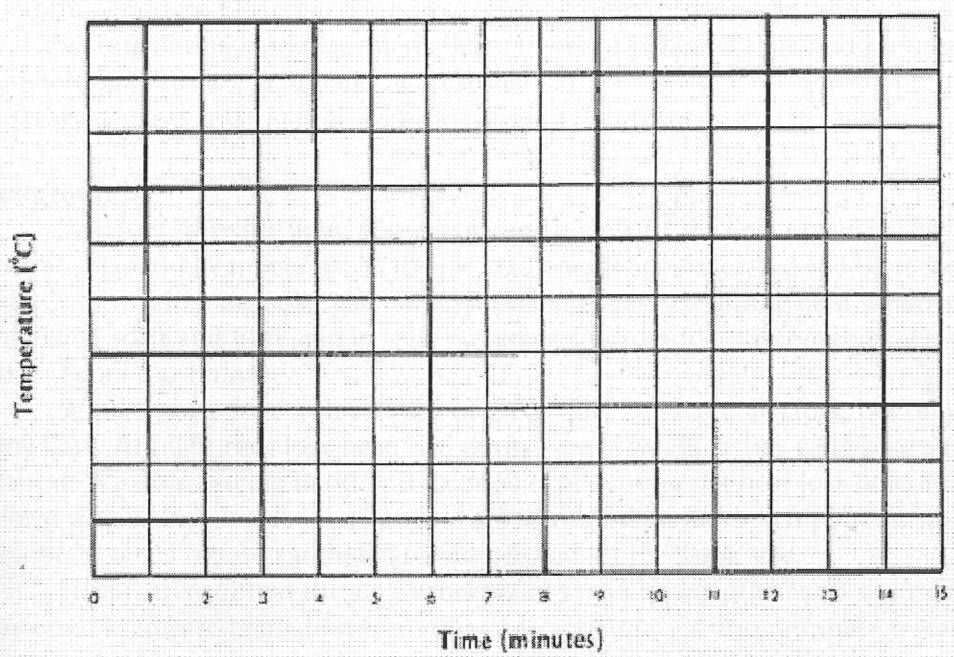
Graph 1

Keeping Heat In



Graph 2

Keeping Heat Out



Window Treatments for Energy Savings

Lesson plan also available online at: http://www.ase.org/educators/lessons/window.pdf

Suggested Grade Levels: 6-9
Disciplines: Science, Technology, Home Economics
Skill Objectives:

- Recording, graphing, and interpreting data
- Researching and taking notes
- Analyzing window needs and recommending window treatments to meet those needs
- Determining advantages and disadvantages of particular window treatments

Major Understandings:

- Windows transmit solar energy. They can be used during cold weather to provide heat by admitting solar energy, but during warm weather solar energy should be blocked in order to prevent excessive heat gain.
- Windows also transmit heat energy. During cold weather, heat should be prevented from escaping through them, but, in warm weather, heat should be prevented from entering through them.
- Window treatments that reduce heat loss or heat gain and also reduce air infiltration can save energy. These treatments vary in cost, effectiveness, durability, ease of installation and use, and attractiveness.
- Energy-saving window treatments include draperies, shades, shutters, panels, and interior storm windows. Different windows require different treatments, depending on their size, shape, orientation, and placement. The factors of personal taste and expense also determine the choice of window treatments.
- Every window treatment has advantages and disadvantages.

Background

Windows provide light, ventilation, and a view of the area outside. They also transmit solar and heat energy. As the price of energy increases, we will be forced to seek methods of maximizing solar gain and minimizing heat loss during cold weather, and of minimizing solar and heat gain in warm weather, in order to conserve the energy needed to heat and cool our homes.

Windows on the south side are of great value as heat collectors, but only on cold, sunny days. At night they lose heat, and during warm weather they can cause a room to overheat. Windows facing in other directions experience a net heat loss on cold days and a net heat gain when outside temperatures are warmer than inside temperatures. Windows can transmit 20 times more heat than an insulated wall of the same size.

Heat is transmitted through windows in several ways: Radiation occurs when heat is transferred as infrared radiation from one object to another through space. Heat is radiated from your body to objects such as windows. Conduction occurs when heat passes through an object from particle to particle. Glass is a good heat conductor and transmits heat from the warmer air touching it. Convection occurs when heat is transferred by the movement of air. In a building, air movements called "drafts" are caused by conduction or by air infiltration. Warm air touching cold window glass, for example, conducts heat to the glass; the air becomes cooler and more dense, and drops toward the floor. Warm air replaces it from above, and a current is set up. A convection current is set up. A convection current can transfer substantial amounts of heat. Infiltration occurs when air leaks through windows and doors around the glas and frame. Infiltration produces drafts and can be eliminated by caulking, weather-stripping, and airtight insulation.

Insulating window treatments will reduce unwanted heat exchange. As long as they can be removed or opened on the south side to permit solar gain when needed, they are an effective means of reducing energy costs and conserving fossil fuels.

Advance Planning

- Duplicate all necessary worksheets.
- Obtain copies of magazines, pamphlets, and books containing information on window treatments. Arrange with the school librarian to use magazines and The Reader's Guide to Periodical Literature. HSU's CCAT and the California state energy office are excellent sources of articles and information.
- Obtain inexpensive thermometers, a fan, and a lamp.
- If desired, suspend the thermometers in the classroom in advance of the activity.
- Prepare a lesson heat loss and gain through windows and prepare to lead discussion in Step 9.

Suggested Time Allotment

1 period to collect data and begin discussion
1/2 period to graph and analyze data
1/2 period to do Reading Activity
2 to 3 periods to conduct research and take notes
1/2 period to complete case studies
1/2 period to answer questions and discuss

Suggested Approach

The discussion in this activity will need much teacher direction. Prepare for leading class discussion.

1. To prevent the temperature reading from becoming monotonous, use the time between the 5-minute readings to do the lightbulb experiment and the infiltration meter experiment, and to begin Part 2 of the procedure (steps 7 and 8).

2. If possible, collect temperature data in front of a window which receives direct sunlight during the class period. Conducting the activity on a partly cloudy day will provide the most dramatic results. Repeating the activity on sunny or cloudy days or in different seasons will also emphasize the dual role of windows in heat loss and solar gain. Extrapolate results to other weather conditions and times of day.

3. Seek out resource people in you community who are knowledgeable about window treatments. These may include homemakers, store managers, building suppliers, cooperative extension agents, and interior decorators. Contact CCAT at HSU – they do periodic workshops on thermal curtain making. Ask them to share their information with class members.

Points for Discussion

- For maximum effectiveness in heating, how can window treatments be used to manage solar gain?
- What are some exterior window treatments which would conserve energy?
- What are the factors which determine the treatment for any window?
- What kinds of treatments could be prepared for classroom windows? For windows in your home?

Typical Results

The graphs should show that the classroom will be warmest at the window when sunlight is penetrating it; will be coolest at the window on cloudy, cold days; and will be warmer as height above the floor increases.

Evaluation

Observe students' participation in class discussion.
Check data tables and graphs for completeness and accuracy.
Check notes for completeness.
Ask students to list kinds of insulating window treatments and to explain the need for them.
Give students a new case study and ask them to recommend a window treatment, listing the advantages and disadvantages of their choice.

Window Treatments for Energy Savings: Student Information

If you've every stood by a window on a sunny day or a cold night, then you know that windows have a lot to do with how comfortable your home feels. Heat moves from warmer to colder areas. Heat will enter through a window on a warmer day but escape through a window on a cold night.

Heat gets around in three ways. One way is radiation. Sunlight is radiation, and most of it passes directly through glass, warming the objects on the other side. Conduction occurs when heat is transmitted through an object. Glass is a good conductor, and transmits heat from warm air that touches it. Convection happens when heat is moved by moving air. When cold air slips in (infiltrates) around the cracks in a window frame, it displaces the warmer air in the room.

All three of these methods of heat transfer affect the comfort of people in houses and buildings. In this activity you will investigate the patterns of heat in your classroom and learn how windows affect a room's comfort. You will find out how to treat windows from the inside to make them more effective in conserving the energy needed to heat or cool your home.

Objectives

At the completion of this activity, you should be able to

- determine the areas in a room which are warmest and coldest and explain why,
- determine the places where air infiltration occurs in a room and explain why,
- list the functions of windows,
- list the kinds of energy-saving window treatments and explain the need for them,
- research energy-saving window treatments in current books and magazines, and
- recommend energy-saving window treatments for various situations, listing their advantages and disadvantages.

Skills and Knowledge You Need

Reading a thermometer
Recording and graphing data
Researching information in current books and magazines
Taking notes

Materials

- lamp with uncovered light bulb
- six Celsius thermometers
- string and masking tape
- colored pencils
- a sheet of plastic, paper, or tissue (15 cm x 15 cm)
- a pencil
- a fan
- current books, pamphlets and magazines containing window treatment information
- index cards

Procedure

Part 1: Collecting Data

1. Turn on the lamp. Cup your hands near the bulb. Describe what you feel. If possible, stand next to a sunny window. Describe what you feel now. *Caution: Do not touch the bulb. It may be very hot.*

2. Suspend six thermometers around the classroom using masking tape and string. Three thermometers should be hung close to the ceiling and three close to the floor. Make sure at least one thermometer is in front of a window. Record the position of each thermometer in Data Table 1 on Worksheet A.
For example, Thermometer 2's position might be "on the back wall, 1 meter above the floor." Also record the outside weather conditions; for example, a partly cloudy day with a temperature of 5 C.

3. Divide the class into six groups. Each group should select a thermometer to read. Every 5 minutes read the temperature of your group's thermometer. Record the thermometer readings of all the groups in Data Table 2.

4. Graph the temperature data from each thermometer on the graph provided (Worksheet B). Use a different colored pencil for each set of data. Write the color used for each thermometer on the key.

5. Take a sheet of paper, plastic, or tissue and tape one edge to a pencil. Hold your "infiltration meter" 15 cm in front of the fan. Then hold it 15 cm behind the fan. Observe the results.

6. Hold this "infiltration meter" in various positions around the edges of several closed windows, either in the classroom or at home. Observe what happens.

7. As a class, make a list of the functions of windows. List as many reasons as you can for why we have windows in our homes.

8. Define radiation, conduction, convection, and infiltration.

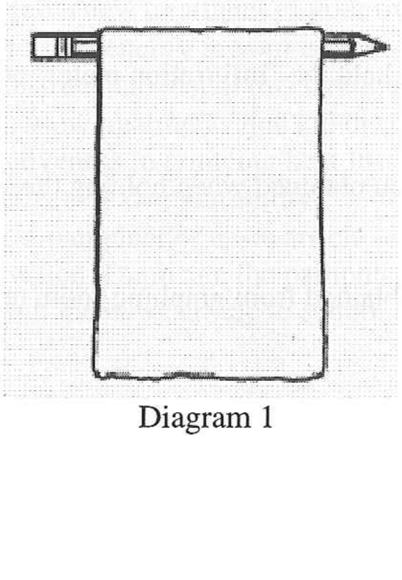


Diagram 1

Part 2: Researching Window Coverings

9. Discuss how and when heat is lost or gained through a window. Be sure to include in your discussion such factors as:
- solar radiation,
- the direction of the window faces,
- the time of day,
- the season of year,
- radiation, conduction and convection
- ventilation,
- infiltration, and
- insulation

10. Do the Reading Activity provided on Worksheet C.

11. Research the kinds of window coverings which can be used to admit more sunlight when needed to help heat the house, to block sunlight when needed to help cool the house, and to reduce heat loss from windows at night or during cloudy periods. Use current books, pamphlets, and magazines. Use index cards to list and take notes on the kinds of window treatments available for solar energy and energy conservation.

12. Read the three case studies provided on Worksheet D.

13. Use your notes and the Reading Activity to recommend a window treatment for each case study situation. Explain why you chose each window treatment.

14. As a class, discuss the advantages and disadvantages of the window treatments recommended for each activity.

Questions

1. What form of heat transfer (radiation, conduction, or convection) were you feeling when you placed your hands near the light bulb? When you stood next to the sunny window?

2. What happened when you held the "infiltration meter" in front of the fan? In back of the fan?

3. What happened when you held the "infiltration meter" at different positions around windows?

4. What caused the results you obtained when holding the "infiltration meter" around meters?

5. Describe the results you obtained from graphing room temperatures. Where was the room warmest? Coldest?

6. How did the temperatures in front of the window compare with those in other parts of

the room? Why?

7. What are the functions of windows?

8. What is window heat loss? How and when does it occur?

9. What is window heat gain? How and when does it occur?

10. List as many energy-saving window treatments as you can.

11. What window treatment did you recommend for each case study? Why?

12. What are the advantages of the window treatment you recommended for each activity? The disadvantages?

Looking Back

You have learned how heat is lost or gained through windows. As energy becomes more expensive, controlling this heat exchange will become more important. One way to conserve energy is through window treatments. During cold weather, these treatments can be opened to allow sunlight in or closed to keep heat in. During warm weather, these treatments can serve an opposite function. They can be closed to keep sunlight and heat out or opened to allow cooling breezes in. When these windows treatments are sealed at the edges to reduce air infiltration, they are even more effective. Each window is unique.

When selecting a window treatment, you should choose the kind of treatment which best meets your needs and tastes and best solves the windows problems. There are many kinds to choose from: draperies, shades, shutters, panels, and interior storm windows. Each varies in cost, attractiveness, effectiveness, and ease of use. The choice is up to you.

Going Further

- Investigate the windows in your own home. What kinds of window treatments are being used now? What kinds of treatments would you recommend to increase energy savings?
- Design, construct, and install a new treatment in your own home.
- Plan a window treatment to save energy in your classroom. As a class or FHA/HERO project, raise money to construct and install this treatment.
- Investigate commercial window treatments that are designed to save energy. Compare their costs, R-values, effectiveness in reducing heat loss or heat gain, ease of installation and use, attractiveness, and durability.
- Use your research to write a pamphlet or news article on window treatments for solar energy and energy conservation. Duplicate the pamphlet for distribution to community groups or submit the news article to school and community newspapers.

Worksheet A: Changes in Room Temperatures

Name ______________________________ Date______________________

Data Table 1- Thermometer Positions

Outside Weather Conditions (°C) ______________________________

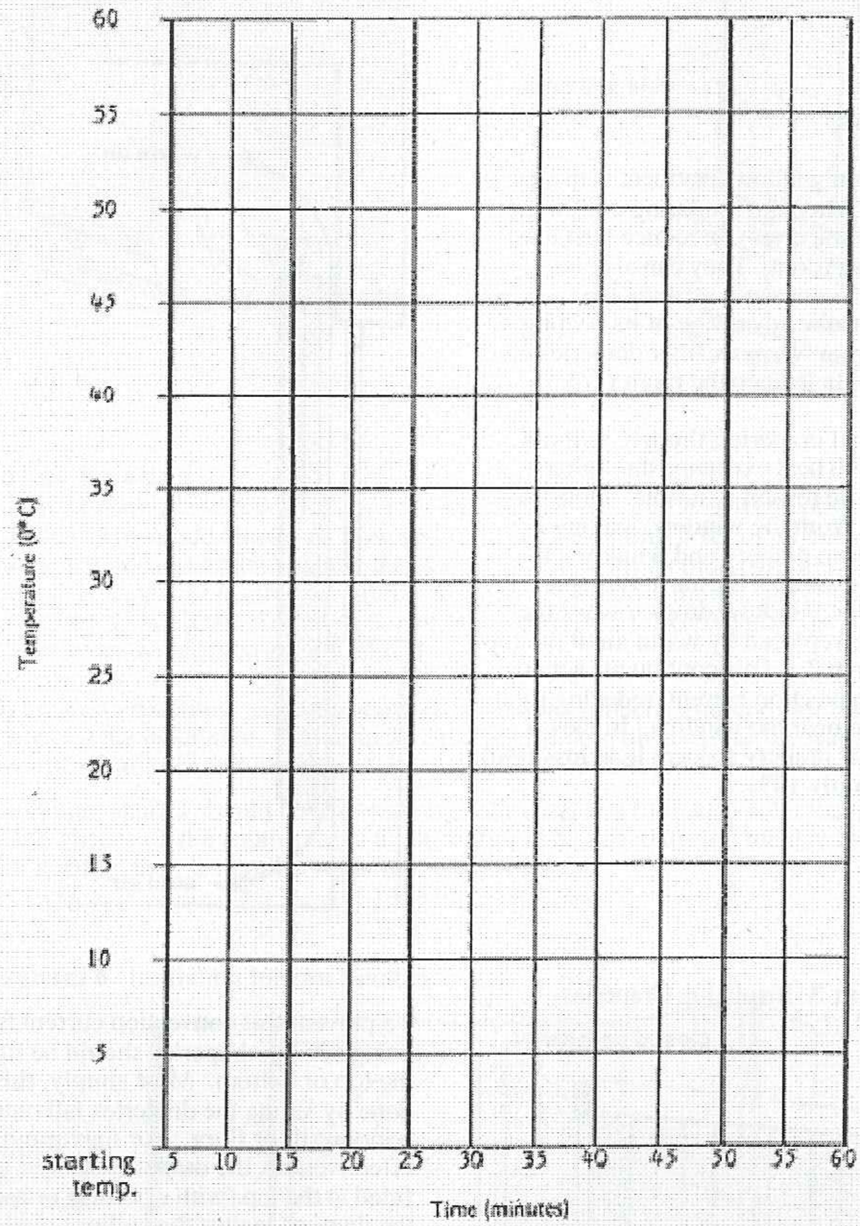
Thermometer	Position
1	
2	
3	
4	
5	
6	

Data Table 2- Room Temperatures over Time Temperature (°C)

	Thermometers					
Time (in minutes)	1	2	3	4	5	6
Starting temperature						
5						
10						
15						
20						
25						
30						
35						
40						
45						
50						
55						
60						

Worksheet B

Changes in Room Temperatures over Time



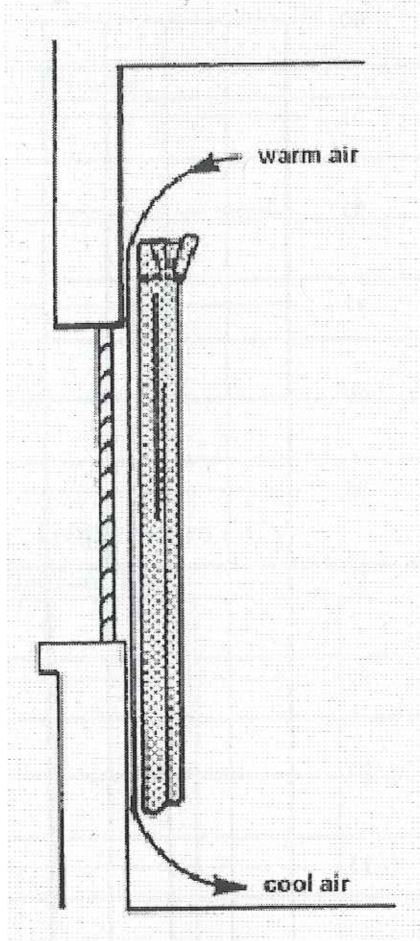
KEY

Thermometer	1	2	3	4	5	6
Color						

Worksheet C: Reading

Interior Window Treatments

Diagram 2 Conventional Draperies

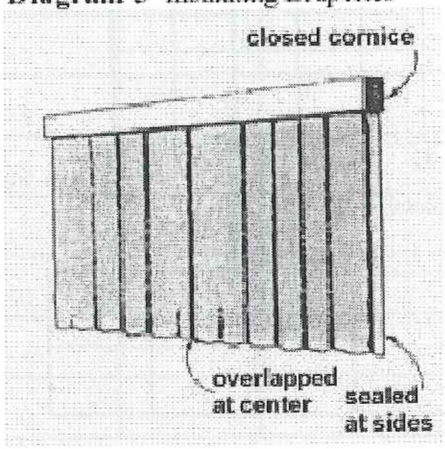


Draperies

One common window treatment is the use of draperies. When drawn during cold weather or at night, draperies can reduce heat loss from a warm room. They can also be opened when the sun is striking the windows to take advantage of its heating effect. During warm weather draperies can be closed to help keep the room cool.

Conventional draperies, though, will not prevent much heat exchange through a window. The reason is simple. Draperies stand away from the window, leaving a space between drapery and window. In winter, for example, the air in this space is cooled by the window, drops toward the floor, and is replaced by warm air at the top. (See Diagram 2.) This continuous action creates a convection current, reducing room temperature near the window. In fact, a conventional drapery reduces heat loss from a room by only 10%.

Diagram 3 Insulating Draperies



To prevent this convection current from being set up, draperies should be fitted at the top or bottom. Most simply, this can be done by letting the draperies fall onto the windowsill or floor. For maximum effectiveness, the draperies should also be fitted at the top (with a cornice or by placing the drapery against the ceiling), sealed at both sides, and overlapped at the center. (See Diagram 3.) Velcro or magnetic tape can be used to attach drapes to the wall at the sides and bottom. This kind of drapery can reduce heat loss as much as 25%. Thermal draperies, with two layers separated by an air space, will reduce heat loss even further.

Diagram 4 Roller Shades, Summer Use

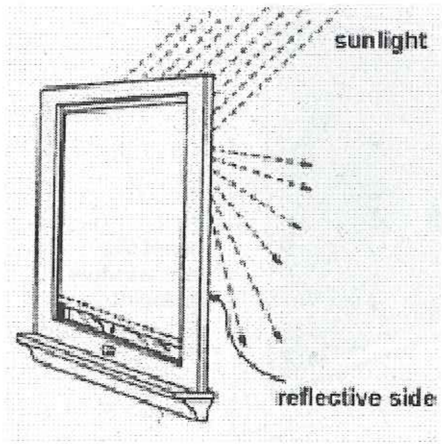
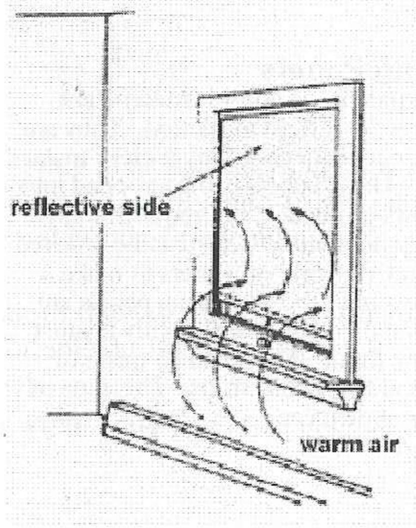


Diagram 5 Roller Shades, Winter Use



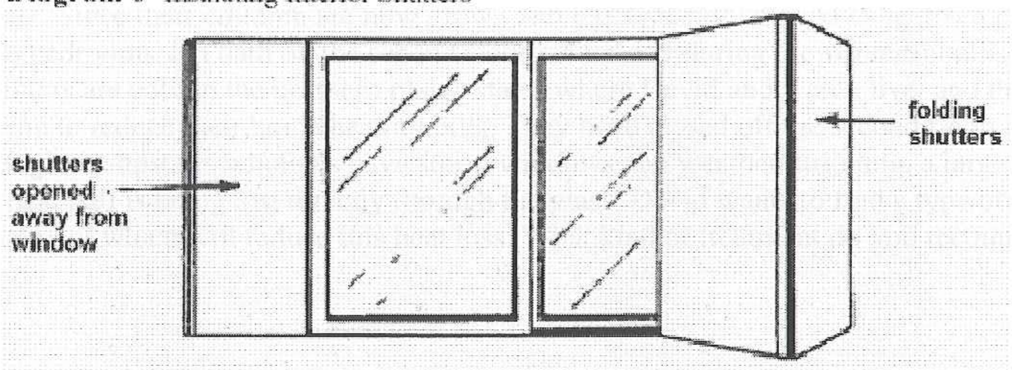
Roller Shades

This most common window treatment is an effective energy saver when properly installed and used. The shade blocks air flow and forms an insulating layer of air between the shade and the window. A roller shade reduces heat exchange by as much as 28%. By adding side tracks, tape, or closures to seal the shade to the window frame, heat exchange can be reduced by 45%. If the shade is made of or covered by a reflective material, this heat exchange can be reduced even further.

For greatest efficiency, a shade should be reversible, reflective on one side and dark-colored on the other side. The reflective material should always face the warmer side -- outward in summer and inward in winter (See Diagrams 4 and 5).

In summer, shades should be lowered on sunlit windows to reduce solar heating. In winter, shades on the south side of a house should be raised during the day to increase solar heating, then lowered at night to reduce heat loss.

Diagram 6 Insulating Interior Shutters



Insulating Shutters

Insulating shutters are a very expensive form of window treatment, but may reduce heat exchange by as much as 80%. They consist primarily of insulation, plywood or wood panels, a vapor barrier, and a decorative covering. Insulating shutters should fit tightly to the frame on all sides to prevent convection currents and to trap an insulating layer of air between the shutter and the window.

Insulating Panels

Insulating panels, or pop-in shutters, are normally made of rigid insulation. They are inexpensive, whether you buy a kit or make your own. These panels can be popped into the windows as needed, but require storage space when not in use. They can be covered with decorative fabric or posters to make them more attractive. Insulating panels are made so that their edges seal tightly against the window frame. Seals can be made of magnetic tape or velcro strips. This type of window treatment can reduce heat exchange by as much as 85%.

Diagram 7 Insulating Panels

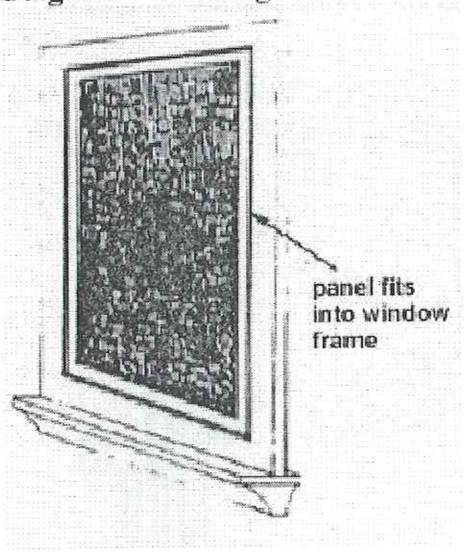
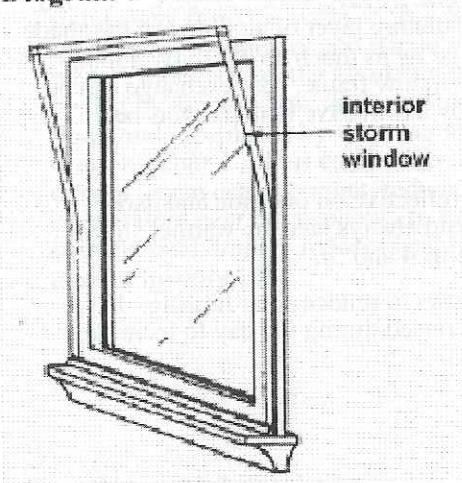


Diagram 8 Plastic Interior Storm Windows



Interior Plastic Storm Windows

A simple and inexpensive way to reduce heat exchange is the interior storm window. It can be made of polyethlyene (like clear garbage bags) or rigid plastic. This window treatment can remain in place all winter and will reduce heat loss by as much as 50%. Flexible plastic can be easily and quickly taped to the window frames. Rigid plastic storm windows must be mounted in the same manner as insulating panels.

Worksheet D: Case Studies

Name ______________________________ Date____________________

Case Study 1

For the winter months, Sue and John will be living in an apartment in New England. The apartment's living room has only one window area, a set of south-facing patio doors which lead to a small balcony. The doors are not tightly fitted and air leaks in around the edges.

For now, Sue and John have a lightweight pair of draw draperies covering the window area, but they want the room to remain comfortable during the coldest winter night. Because they are on a limited budget, the newly-married couple does not have much money to spend on window coverings. What window treatment would you recommend for this couple's living room?

Case Study 2

Jim has just moved into a college dorm in a southwestern town. His corner room has two windows, one facing south and the other west. Although the room is air-conditioned, the heat from the sunlight entering the windows makes the room very uncomfortable by late afternoon. Jim would like to select a covering for his windows that will be attractive, but will also help to keep the room cool. What window treatment do you recommend for Jim's dormitory room?

Case Study 3

Karen and David have lived in their story-and-a-half Cape Cod home for over twenty years. Since their children are now grown and have recently moved away from home, the two bedrooms and bath on the second floor are unused during the winter months. Winters are cold in the northern plains states where David and Karen live, and they are trying to reduce their home heating bills. They have closed off the second floor. Even though the upstairs windows have storm windows and weather-stripping, a large amount of heat still is being lost directly through the glass. David wants to find a type of window treatment which will reduce this heat loss. What kind of treatment do you recommend?

Energy Transformation

Lesson plan also available online at: http://www.ase.org/educators/lessons/e-trans.pdf

Suggested Grade Levels: 7-9
Disciplines: Science, Technology, Mathematics
Skill Objectives:

- Conducting an experiment
- Recording data and observations during an experiment
- Reading and interpreting a chart containing numbers
- Solving word problems in math

Major Understandings

Each fossil fuel contains a different amount of energy per unit of weight.
Various units are used to measure energy content.
These units of measurement can be converted from one to the other.

Background

Fossil fuels provide most of the energy used in the world today. Despite the many problems associated with their use, they will continue to be our mainstay for years to come. In light of this, it is important that students become familiar with some of the characteristics of fossil fuels, so that they can deal intelligently with energy issues as they arise.
Fossil fuel energy content is well documented. The chart given in this activity is representative of most that are published. In no way should these figures be thought of as the amount of energy which is available as usable energy after the conversion process. Losses are large in most conversion processes and efficiencies never approach 100%. This point should be discussed with students as part of this activity. (See Fossil Fuels Activity 2- pages 2-4 and 2-6.)

Advance Planning

- The instructor should do the computations and complete the answers on Worksheets B and C.
- Have a supply of crushed ice in an insulated container on hand for the experiment.
- Check with math teachers to see if students have sufficient background to do the word problems.
- For "Going Further," check with your librarian to find out whether information is available on Liquid Petroleum and natural gas. If it is not, your librarian can obtain it from other libraries or from local LP gas dealers.

Suggested Time Allotment

One period to present background material, look up definitions for "Words You'll Learn," and read Worksheet A
One period to complete Worksheet B
One period to conduct the experiment on Worksheet C, record data, and answer questions
One period to discuss the answers to the questions on Worksheets B and C

Suggested Approach

1. Using the vocabulary from "Words You'll Learn," discuss the energy content of fossil fuels and the methods of transforming that energy into usable forms. Introduce the units used for measuring energy content.

2. Allow students to use a calculator to do the computations on Worksheets B and C.

3. Have students complete Worksheet B. Allow students to work as partners to complete the worksheet.

4. Have students perform the experiment on Worksheet C. Allow students to work in small groups when completing the experiment. Go over the results of the experiment and the answers to the word problems. If desired, the experiment can be done as a teacher demonstration.

5. Rather than weighing out one pound of water and one pound of water-ice mixture, you may wish to use volume by the students measuring 454 mL (454 g). Celsius temperature readings may be converted to Fahrenheit, if necessary, using $9/5\ (C) + 32 = F$
If students show interest, have them do follow-up such as one of those listed in the "Going Further" section.

Precautions

Review safety precautions relating to using fire, heating liquids, and burning natural gas.
Caution the students about proper handling of the thermometers to insure accurate temperature reading.

Points for Discussion

- How does the energy content of each fossil fuel compare to that of the others?
- When the energy stored in fossil fuels is converted for use, what form of energy usually results?
- What method of transformation is most commonly used to obtain energy from fossil fuels?
- What are the advantages and disadvantages of fossil fuel use? Consider heat content, ease of conversion, environmental problems, etc.

Typical Results

Some students will need to have word problems broken down in steps.
Students will be able to convert from one energy unit to another.
If students perform the wrong arithmetic operations, their results will be unlikely. They should be encouraged to refer to Table 2 on Worksheet B to see if their answers are reasonable.
Students should infer that some heat energy was used to melt the ice, since the mixture was heated but there was no temperature change until the ice melted. (Latent heat is the change in heat content of a substance when its physical state is changed without a change in temperature.)

Key
Worksheet B
1. Natural gas
2. Peat
3. 3,500,000 / 3413 = 1,025.49 kWh
4. 25,000,000/ 3413 = 7324.93 kWh
5. 25,000,000/ 5,600,000 = 4.464 barrels
6. 1,410,579 / 42 = 33585.21 kcal
7. 38,000,000 - 37,000,000 = 1,000,000 Btu
8. 3413 X 10,000 = 34,130,000 Btu / 25,000,000 = 1.365
9. 3.97 X 20,000 = 79,400 / 47,000,000 = .00169 tons

Worksheet C
1. (Responses depend on D T. Here a 25 °F change for 5 minutes is assumed.)
number of Btu = 1 lb x D T
1 x 25 = 25 Btu
number kcal = .252 x number of Btu = .252 X 25 = 6.3 kcal
number of therms = number of Btu / 100,000 = 25 / 100,000 = .00025 therms
number of kilowatt-hours = number of Btu / 3,413 = 25 / 3,413 = .00073 kWh
2. Students should predict a DT that is the average of "Heating Trial One" and "Heating Trial Two".
3. The heat energy is being used to melt ice so there should be no change in temperature as long as the ice remains in the mixture.
4. Student questions should have to do with their actual result (no change) not matching their predicted result (same amount of change as before.) This provides an opportunity for you to discuss latent heat.

Evaluation
Give a quiz on the terms from "Words You'll Learn."
Evaluate student responses on Worksheets B and C.
Student responses in discussion may be used as an indicator of understanding of the concepts.

Modifications
- A propane torch may be substituted for the Bunsen burner.
- Develop a computer program based on the information and word problems on Worksheet B.
- Have students use the information regarding energy consumption from utility bills and practice converting the energy units.

Energy Transformations: Student Information

The main source of the world's energy for the last century has been fossil fuels. Coal and peat, oil (petroleum), and natural gas - formed from the fossils of once living things - are the primary fuels used to power today's society.

To use fossil fuels we must be able to locate and recover them at affordable costs, convert them to usuable forms (such as electricity or heat), and use them without wasting them or harming the environment.

Each type of fossil fuel releases a different amount of energy. This energy can be measured in a variety of units. In this activity you will investigate the amount of energy each type of fossil fuel can provide, and the various units used to measure this energy. You will also observe the transformation of a fossil fuel into a usable form of energy, and measure that energy using various units.

Objectives

At the completion of this activity, you should be able to

- show an understanding of the amount of energy found in each kind of fossil fuel,
- list the various units used to measure the energy content of fossil fuels,
- convert these energy units from one unit to another, and
- measure the heat energy obtained from a fossil fuel.

Skills and Knowledge You Need

Safety skills needed to light a propane torch or Bunsen burner and to heat water
Ability to read data tables
Ability to do math calculations needed to solve word problems and conversion problems
Ability to read a thermometer

Words You'll Learn

- anthracite coal
- barrel
- bituminous coal
- Btu
- calorie
- convert
- crude oil
- gasoline
- kilocalorie
- kilowatt
- kilowatt-hour
- peat
- therm
- transformation
- watt

Materials

- Worksheets A, B, C
- calculator (optional)
- clock or watch
- thermometer
- propane torch or Bunsen burner
- water
- ice
- ringstand
- large pyrex beaker to hold 1 quart of water
- safety glasses
- stirring rod

Procedure

1. Look up the definitions for the "Words You'll Learn." Some of the definitions are provided for you on Worksheet A (Units Used for Measuring Energy Content).

2. Worksheet B contains two tables. Table 1 shows the amount of energy contained in five kinds of fossil fuels. Table 2 shows the relationship between different units of energy measurement. Using the information from these tables, answer the questions from the worksheet.

3. Do the experiment on Worksheet C. Follow the directions given, recording your temperatures and predictions on the data table.

4. Answer the questions on Worksheet C. (You will need to refer back to the conversion chart on Worksheet B.)

Questions

1. The Bunsen burner burns natural gas. What usable form of energy was obtained from the natural gas?

2. Based on this activity, which fossil fuels do you think are most desirable to use?

3. Why is it useful to know the relationship between the various energy units?

4. When a water-ice mixture is heated, what action takes place first that makes use of heat energy?

Looking Back

Fossil fuels come in a variety of forms and contain different amounts of energy. This activity has shown you the energy content of different fossil fuels, as well as some of the units used to measure this energy.

Energy content is only one factor to consider in selecting the best fuel for a particular use. The ease of transforming the fuel to usable forms of energy is another factor. (In this experiment you have observed the transformation of natural gas, a fossil fuel, to heat energy.) There are other factors to consider in selecting a fossil fuel. These include the cost, the ease of extracting, processing, and transporting the fuel, and the environmental effects of both extracting and using it.

Going Further

- Use information from the library to compare the advantages and disadvantages of using coal, oil, and natural gas (cost, availability, environmental problems, etc.)
- Using sources from your library, find out what substances are found in natural gas and LP gas. Write a paragraph about these substances based on your library research.
- Contact a local LP gas dealer and ask for information on uses, safety procedures, and production methods for LP gas.
- Invite a guest speaker to discuss current topics relating to fossil fuels: mine safety, environmental problems, toxic waste, etc.
- Examine ways of transforming fossil fuels to obtain their energy. Do an experiment to obtain methane from coal.
- Using the information on conversion efficiencies from Fossil Fuels Activity 2, determine the amount of energy obtained from each fossil fuel using various energy conversion devices.
- Watch a demonstration of the heating of a water-ice mixture that continues past the time when the water boils. As you observe the demonstration, record heating intervals and temperature readings. Display the data on a graph. Read about latent heat and relate that phrase to the graphic display of data.

Worksheet A: Units Used for Measuring Energy Content

Barrel: a liquid volume equal to 42 gallons or 159 liters. One barrel of crude oil has about the same heat energy as 448 pounds of bituminous coal, 5,600,000 Btu, or 1,410,579 kilocalories.

Btu: British thermal unit, a unit for measuring heat energy; Btu is the quantity of heat necessary to raise the temperature of one pound of water one degree Fahrenheit, about one-fourth of a kilocalorie (252 calories).

Calorie: (also: gram calorie) a unit of heat energy; the amount of heat needed to raise the temperature of one gram of water one Celsius degree. It equals 0.00397 Btu.

Kilocalorie: (kcal) a unit of heat energy equal to 1,000 calories, sometimes called a Calorie or food Calorie.

Kilowatt: a measure of power, usually electrical power or heat flow; equal to 1,000 watts or 3,413 Btu per hour.

Kilowatt-hour: (kWh) the amount of energy equivalent to one kilowatt of power being used for one hour; equal 3,413 Btu, or 860 kcal.

Therm: a unit of measure of the heat energy in 100 cubic feet of natural gas. Equal to 100,000 Btu.

Watt: a small measure of power, usually electrical power or heat flow; equal to 3.143 Btu per hour. One horsepower =746 watts.

Worksheet B:
Energy Content and Energy Conversion of Fossil Fuels

Name ______________________________ Date______________________

Directions: Use the following tables to answer the questions below.

Table 1
Energy Content of Fossil Fuels

FUEL	ENERGY CONTENT (Btu/Ton)
Coal (Anthracite and Bituminous)	25,000,000
Peat	3,500,000
Gasoline	38,000,000
Natural Gas	47,000,000
Crude Oil	37,000,000

Table 2
Conversion Chart for Energy Units

one Btu	= .252 kilocalorie = .000293 kilowatt-hour
one kilocalorie	= 3.97 Btu = .0012 kilowatt-hour
one kilowatt-hour	= 3,413 Btu = 860 kilocalories
one barrel of oil(42 U.S. gallons)	= 5,600,000 Btu = 1,410,579 kilocalories = 1,640.8 kilowatt-hours

Questions

1. Which fuel has the greatest energy content per ton?
2. Which fuel has the least energy per ton?
3. How many kilowatt-hours of electricity could you get from a ton of peat?
4. How many kilowatt-hours of electricity could you get from a ton of coal?
5. How many barrels of oil would give you the same energy as a ton of coal?
6. How many kilocalories are there in one gallon of oil?
7. How many more Btu per ton does gasoline have than crude oil?
8. How many tons of coal would be needed to produce 10,000 kilowatt-hours of electricity?
9. How many tons of natural gas would be needed to produce 20,000 kilocalories of heat energy?

Worksheet C:
Converting and Measuring the Energy in a Fossil Fuel

Name ________________________________ Date______________________

Directions: Follow the steps below to obtain heat energy from natural gas. Use a Fahrenheit thermometer because the Btu's and therms used later are English system units.

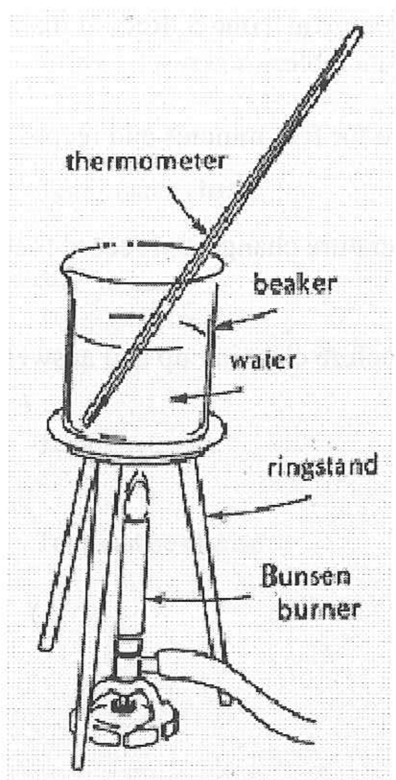
1. Pay careful attention to the safety instructions provided by your teacher on the safe use of the Bunsen burner or other kind of gas burner provided. Wear your safety glasses.

2. Fill a large pyrex beaker with enough tap water to weigh one pound (approximately 450 mL). Note: the total weight should equal one pound of water plus the weight of the beaker.

3. Stir the water with a stirring rod. Then lift the thermometer off the bottom of the baker and read the temperature of the water. Record that temperature under "Heating Trial One" in the data table. The initial time is "Time 0."

4. Set up the apparatus as shown in the diagram. The beaker should be about 3 inches above the top of the burner. Light and adjust the burner to medium-low flame.

Diagram



5. Use the stirring rod to mix the water as you apply heat as directed by your teacher. At the end of 5 minutes, measure the temperature of the water. Record that temperature under "Heating Trial One" in the data table beside "Time 5."

6. Let the system cool at least three minutes. Repeat Directions for steps "3" and "5". This time your "Time 0" temperature will be higher since the original tap water has been heated somewhat. After heating, record the new temperature measurements under "Heating Trial Two" on the data table.

7. Calculate the temperature change for each trial of the two heatings and record these calculations under the appropriate heating trials. Compare the changes with each other. Check with your teacher to see if more trials are necessary before you proceed to step eight.

8. Refill the beaker with tap water and plenty of ice which together weigh one pound. Note: the total weight should equal one pound of water and ice plus the weight of the beaker. Remember to stir the water-ice mixture. Read the thermometer until the temperature remains steady. Record that temperature under "Heating Trial Final" in the data table.

9. Based upon the data you collected previously, how many degrees do you predict the temperature of the ice-water mixture will rise when you heat it for five minutes? Record your prediction under "Heating Trial Final" in the data table.

10. Based on the Time 0 water-ice mixture and your predicted temperature change calculate the predicted temperature at Time 5. Record that calculated prediction under "Heating Trial Final" in the data table.

11. Heat the water-ice mixture for five minutes and record your results under "Heating Trial Final" in the data table.

12. Calculate the actual temperature change and record that calculation under "Heating Trial Final" in the data table.

13. Check with your teacher before cleaning up and answering the "Questions."

Data Table

Name ________________________________ Date______________________

Heating Trial One

Time 0,

Tap water temperature _____° F

Time 5,

Water temperature _____° F

Temperature change _____° F

Heating Trial Two

Time 0,

Water temperature _____° F

Time 5,

Water temperature _____° F

Temperature change _____° F

Heating Trial Final

Time 0,

Water-ice temperature _____° F

Predicted,

Temperature change _____° F

Predicted,

Temp. at Time 5 _____° F

Time 5,

Temp. water-ice _____° F

Actual,

Temperature change _____° F

Questions

Name ______________________________ Date______________________

1. Using Worksheets A and B calculate:

   a. How many Btu's of heat energy were needed to change the tap water's temperature to the new temperature reached in "Heating Trial One"? _____ Btu

   b. How many kilocalories of heat energy were needed? _____ kcal

   c. How many therms of heat energy were needed? ____ therm

   d. How many kilowatt-hours of heat energy were needed? _____ kWh

2. How many degreees in temperature did you predict the water-ice mixture would rise in five minutes? _____ ° F

3. How many degrees did the temperature actually rise? _____ ° F

4. You have probably experienced a discrepancy. One of the times a discrepancy occurs is when there is a difference between what you expected to observe and what you actually did observe. What questions do you have as a result of the discrepancy you observed?

Saving Energy –Teaching Unit

Lesson plan also available online at:
http://csf.concord.org/esf/Curriculum/Curriculum_DisplayUnit.cfm?ViewID=118

Grade Level: 6 - 8
Curriculum Area: Science
Timeframe: 10 – 15 sessions, 705 minutes total estimated time

Overview

This unit was designed to expose students to the importance of conserving energy. Many children already realize that they should cut off the lights or the television when they finish watching; however, aside from saving "electricity" and saving money, they have not grasped the significance of conserving our energy resources. 80-90% of the energy we use to perform daily activities comes from burning fossil fuels. Consequently, with rapid technological advances, our fossil fuel usage rate is steadily increasing at an alarming rate. Because fossil fuel resources are non-renewable, our excessive use will eventually lead to depletion of our primary energy resource. How will this affect the quality of life of the children, and their children's children, and so on?

In addition to discovering the true implications of relying primarily on a non-renewable energy resource (one that we excessively squander), the students will investigate other consequences of excessive use of fossil fuel resources. In "inquiry centers", the students will investigate the environmental problem of global warming which is related to the use of fossil fuels. Through a series of simulations, experiments, hands-on activities, and some research, the students will learn how not conserving fossil fuels will lead to environmental problems that will affect many aspects of their very own lives in the future. The students will also use the Internet to access the most current information related to these issues.
Finally, they will investigate possible solutions to help decrease the harmful effects of excessive burning of fossil fuels, as well as solutions for conservation of resources.

Essential Question

Why should I care about saving energy?

Subquestions

* Why are fossil fuels considered non-renewable, and how might this affect our future?
* What factors contribute to increased use of energy (fossil fuels)?
* How would our quality of life change if our current rate of use continues?
* How does excessive use of fossil fuels affect our environment?
* What are the causes and affects of global warming?
* What are some solutions to conserve our fossil fuel reserves, and help the environment?

Results

Students will:
- identify the problems of using non-renewable resources for energy.
- infer reasons for decreasing availability of fossil fuel resources.
- make inferences based on graphed data.
- construct a chart showing how technological advances have contributed to increase usage

of fossil fuels.
- describe how the excessive burning of fossil fuels contribute to the environmental problem global warming.
- document their energy usage for a day.
- analyze their usage, and propose an energy saving plan.

Preparation

Classroom Preparation:

This unit is best suited for cooperative group work. Students should be grouped in heterogeneous groups of 3-5 if possible. Access to classroom computers or a computer lab is preferable, if not required for some of the activities presented in this unit.

An Inquiry Journal is included as a part of this lesson. The journal is for students to record their data, brainstorming ideas, and follow up assignments. Journal pages corresponding to each lesson are included after each lesson. As students add to their journal while going through the lessons, they will end the unit with the completed Inquiry Journal. Review the journal sheets before beginning the unit so that you will be familiar with the correlation to the lesson and activities. Reminder notes are included as to when students should record information in Inquiry Journals.

Learner Preparation:

Students should have a basic understanding of fossil fuels; they should know where they come from, and their general uses. Each student should have an Inquiry Journal when the unit begins.

Resources

Resources/Bibliography:

World Resources Instititute. Merrill Science Book, Merill Publishing Company, 1989

The Internet:

www.epa.gov   www.eren.gov   www.sandia.gov/ESTEEM/

Community Contacts:

Local Power Companies

Ask an Energy Expert (www.eren.doe.gov/)

Technology:

The Internet, SimEarth, The SunJoule's, Model It

Professional Resources:

Teachers Guide To World Resources, World Resources Institute

Unit Artifacts:

Inquiry Journal

Energy Consumption Log/Peer Consultation Sheet

Unit Post Test

Teaching Procedures
(For the underlined items below, please see this lesson plan's website at:
http://csf.concord.org/esf/Curriculum/Curriculum_DisplayUnit.cfm?ViewID=118)

1. 25 min — Have students respond to unit Pre-Test Questions in Inquiry Journal. After about 10 minutes, share and discuss responses to pre-test.

Add a Performance Task for this Step

2. 20 min — Introduce the unit by asking the class if they have heard their parents say any of the following phrases: "Cut off the lights when you're not using them; you're wasting electricity.", "What is that T.V. still doing on; you're not watching it; you're wasting electricity." The idea starters should get students to connect with the fact that some of us know that we should do certain basic things to save energy; but why is it actually important? Have students brainstorm a list of reasons why it is important to conserve energy in Journal Entry 2.

Add a Performance Task for this Step

3. 30 min — Ask students "From what sources do we obtain our energy?" and "Will our energy ever run out?" Have students share responses with the class. On the board, create a class list from their responses. Spend a few minutes discussing responses and sharing reactions. Write on the board: "FACT: FOSSIL FUELS ARE NON-RENEWABLE!!" Ask students to write in Journal Entry 2 what that statement means.

Add a Performance Task for this Step

4. 30 min — Students participate in Countdown of Resources activity which simulates the act of locating non-renewable resources and exposes students to the problems associated with increased usage over time. Students will use the Countdown Activity Sheet and Journal Entry 3 to record observations and answer questions about the activity. Graphs created by students and a follow-up discussion will provide an opportunity for assessment.

Add a Performance Task for this Step

5. 45 min — Display a transparency of Global Fossil Fuel Consumption. Ask students to write one sentence summarizing the information and trends revealed by the graph in Inquiry Journal Entry 4. Have students complete Past, Present, Future collage activity.

Add a Performance Task for this Step

6. 45 min — Students complete a creative writing activity describing their lives in the past, the present and the future and enter it in their Inquiry Journals as Journal Entry 5 . This writing assignment will serve as an assessment tool.

Add a Performance Task for this Step

7. 60 min — Students will complete the SimEarth Activity recording information on the Graph Paper provided. Upon completion of the activity, students will answer follow-up questions in Journal Entry 6. Student understanding will be assessed based on discussion within groups and class discussion, as well as answers to the follow-up questions.

Add a Performance Task for this Step

8. 30 min — Review the implications of fossil fuels being non-renewable. Students brainstorm a list of other possible problems with excessive use of fossil fuels and record them in Journal Entry 7. Discuss the observations from the SimEarth simulation. Remind students that the fossil fuel supplies plummeted; but have them recall what happened to the other factors. . Focus the students on environmental consequences. Discuss how the burning of fossil fuels contribute to many kinds of pollution. Explain that the students will be working in groups to investigate the issue of global warming.

Add a Performance Task for this Step

9. 45 min — Students participate in Simulating the Greenhouse Effect and record observations and reactions in Journal Entry 8. After the demonstration, discuss with the class Connecting the Greenhouse Effect to Global Warming . Groups of students will produce a list of four things that might happen to our planet if temperatures continue to increase.

Add a Performance Task for this Step

10. 60 min — The teacher models the rise of sea level that would result from global warming in the activity Rising Sea Level. Students record observations and reactions in Journal Entry 9.

Add a Performance Task for this Step

11. 60 min — Students start thinking about Solutions to the problem of global warming. Observations and reactions are recorded in Journal Entry 10.

Add a Performance Task for this Step

12. 60 min — What About The Future? Students keep an Energy Conservation Log in Journal Entry 11 to track energy usage in their homes. After the week, students exchange logs and complete a Partner Consultation Log in Journal Entry 12. The Energy Consumption Log and peer response skills while consulting with partner will serve as assessment.

Add a Performance Task for this Step

13. 45 min — Students create a poster of energy savings tips to serve as a reminder of what they have learned. Posters can be assessed by means of the Poster Rubric.

Add a Performance Task for this Step

14. 45 min — Students contact their local power company to interview a representative. Students will use Journal Entry 13 - Power Company Information Sheet to record information. Teacher Tips will help organize this activity.

Add a Performance Task for this Step

15. 60 min — Students will use Model-It software to create a cause and effect model of the topics discussed in this unit. They will begin with themselves, then illustrate the relationships between their energy use and factors such as pollution, quality of life, fossil fuel supplies, etc. Teacher and students may evaluate the models with the Model-It Rubric.

Add a Performance Task for this Step

16. 45 min — Students take a Post test (Journal Entry 14) to show what they have learned.

Add a Performance Task for this Step

705 min **Total Estimated Time**

Is Hunger a Global Problem? -- Teaching Unit

Lesson plan also available online at:
http://csf.concord.org/esf/Curriculum/Curriculum_DisplayUnit.cfm?ViewID=153

Grade Level: 6 - 8
Timeframe: 1540 min total estimated time

Overview

This unit provides learning tasks and experiences for students in 6th through 8th grades in math and social studies to focus on the issue of hunger as a global problem, Is Hunger Sustainable?, as it relates to the Education for a Sustainable Future topic of Global Issues. Through an exploration of Global Issues, students will become more aware of how the development and implementation of global sustainable development policies, standards of conduct, and trade and foreign policies influence the achievement of sustainable. Sustainable development issues are personal, local, regional, national, and global. Students will understand how globalization with forces external to their community or individual lives can affect the outcome of their desired futures, and how their actions can influence those beyond their immediate sphere.

Through activities such as Internet, library research, and personal interviews, students will build spreadsheets, various types of graphs, and present their findings through visual organizers and slide shows. The culmination of the unit will be a model of sustainable community built through the use of "Model-It" and "What If Builder" software.

Essential Question

Is hunger sustainable?

Subquestions

1. Does overpopulation cause hunger?
2. Should developed nations aid the world's hunger?
3. Can the problem of world hunger be solved?

Results

Students will:

- understand systems that affect the future – have a deep understanding of complex environmental, economic, and social systems
- understand connections – comprehend the importance of the interconnectedness of these systems in a sustainable world
- understand multiple perspectives – respect the diversity of points of view and interpretations of these complex issues from cultural, ethnic, religious, and intergenerational perspectives
- build systems thinking capabilities- understand cause and effect, change over time, strategic planning, "what-if analysis", leverage points

- Student will:
1. Develop a systems thinking approach to sustainability:
· Identify environment, economic, and social systems and the relationship between their sub components
· Understand processes by which these systems behave and change over time
· Understand how the elements of these systems are distributed over the earth and in human society

2. Understand sustainability through making and understanding connections and interactions between environmental, economic and social systems:
· Understand the interconnectedness of present and future political, economic, environmental and social issues
· Utilize and create models that define and describe the interactions within and between environmental, social, and economic systems and predict probable interactions and outcomes
· Map systems behavior focusing on cause and effect (causal loops) and change over time (BOTG)
· Understand the philosophies and patterns of economic activity and their effects on the environment, societies and cultures
· Become knowledgeable of indicators used to measure the degree to which individuals, communities and nations are on a path to sustainable development
· Understand the implications and trends of global issues, such as process of urbanization, rise in nationalism, borderless information flow, expansion of democracy, water distribution, food production, climate change, populations, and globalizing capitalism, and how they impact the opportunity for sustainability

3. View sustainability through multiple perspectives:
· Understand the relationships between personal, community and global visions for a sustainable future
· Be able to argue all sides of an issue with a strong basis of understanding the other viewpoint
· Become aware of cooperative international and national efforts to solve global issues and to implement strategies for a more sustainable future
· Apply broad and diverse definitions of fundamental concepts, such as environment, community, development and technology, to local, national and global experiences
· Understand the implications of the political, economic and social cultural changes needed for a more sustainable future for individuals, families, and local and global communities
· Understand the processes of planning, policy-making and action for sustainability by governments, businesses, non-government organizations and the public

Preparation
Preparation for the implementation of this unit will include much teacher research and setting up of bookmarked sites. The teacher will also need to seek out and arrange for a suitable guest speaker from a local food bank.
The teacher also needs to locate and be trained on various technology programs: Excel, What If Builder, Model-It, PowerPoint Students will need to be trained as well..

Resources

http://www.oneworld.org/ips2/oct98/20_46_079.htmlhttp://www.fao.org/library/dlubin/DsitesE.htm

http://www.brown.edu/Departments/World_Hunger_Program/

http://arborcom.com/frame/foodcook.htm#Food

http://ficinfo.health.org/brochure/labeled.htm

http://vm.cfsan.fda.gov/list.html

http://gourmetconnection.com/ezine/calorie.shtml

gopher://gaia.info.usaid.gov:70/11/regional_country

http://lcweb2.loc.gov/frd/cs/cshome.html

http://www.odci.gov/cia/publications/factbook/index.html

http://www.lib.utexas.edu/Libs/PCL/Map_collection/map_sites/map_sites.html

http://w3.acdi-cida.gc.ca/virtual.nsf/pages/index_e.htm

Teaching Procedures
(For the underlined items below, please see this lesson plan's website at:
http://csf.concord.org/esf/Curriculum/Curriculum_DisplayUnit.cfm?ViewID=153)

1. Administer Pre Post Test.
50 min **Teacher Background Information**: Read the article entitled, "FOOD: New Report Exposes Myths About World Hunger."

Add a Performance Task for this Step

2. **Hook: Issue Mapping**
50 min On large chart paper, create a class issue map. Do this by having groups or teams of students first discuss various reasons why people are hungry, then come to a consensus as to the top 5 reasons and share those reasons with the rest of the class. Through whole class discussion, categorize the results of the groups' responses on the class issue map. Look for possible themes. Guide students toward identifying economic, environmental, societal, technological, and political issues. Keep the issue map prominently displayed during this unit.
Activity: Video Show the following video (or another video appropriate to the hunger issue) to the students: " 40,000 a Day" (running time: 20 minutes). See Resources section for ordering details.
Conclusion: Lead a class dicussion on how the video made them feel.
Assessment: Following the class discussion on the video, have students write a journal

entry responding to the questions: "What does food mean to you? How important would you rank it in your life? How does hunger feel?"
Use a 3-Pt Scale to grade the journals.

Add a Performance Task for this Step

3. 90 min **Hook:** Ask students to explain the differences between the following forms of hunger: *malnutrition, undernourishment, undernutrition, and wasting.* Then ask students to compare these terms with the word *hunger.* (Refer to the teacher resource: Definitions for Hunger.)
Activity: Give each student a template with a circle divided into four equal quadrants (Appointment Clock). Guide students through the activities described in Student Activity 1 . (Hand out these sheets).
Conclusion: Within a group, students will use the information obtained from interviews (Appointment Clock) to design a visual organizer that defines hunger, malnutrition, and starvation. Each group will present their visual organizer to the rest of the class.
Assessment: Students will be graded by the 5 Point Clock Checklist.

Add a Performance Task for this Step

4. 60 min **Hook:** Ask the question, "How many calories does an average adult human being need to survive?" Other related questions may be researched given time.
Activity: Take students to computer lab or media center to research the answer to the Hook question.
Teacher Resource: In preparation for the next step, refer to the Definition Sheet.

Add a Performance Task for this Step

5. 180 min **Hook:** Allow time for students to share the results of their research from the last lesson. Come to a consensus on the answer. The average adult needs about 2000-2700 calories to survive.
Activity: Hand out the Student Activity 2. Guide students through the two parts to this lesson. The first part will be done individually. Students will create two menus. One menu will be based on the foods they like; one menu will be based on the least cost foods. Both menus will be based on the number of calories an average human needs to survive. Students will then cut out pictures to match the menu and paste them on paper plates. Upon sharing these plates, the class will calculate the average cost of the foods on each plate. Then the class will calculate the cost per unit calorie.
Assessment: The Menu Rubric will be used as the assessment tool for this activity.
The second part of this lesson will involve group work. Divide the students into teams of four or five students each. Each team will keep a log of everything they eat for a week. The log will track the team's data by day and by the week, converting the data into calorie intake. Then the team will extrapolate the data as to its yearly intake and average the daily intake from that information. Finally, the team will graph their data and report their findings to the rest of the class.
Conclusion: Guide the entire class in multiplying the cost averages for the foods that they like to eat and the lowest cost foods in order to calculate how much is being spent per calorie consumed.
Assessment: The team work will be assessed according to the completeness of the data put into spreadsheets, the accuracy of the mathematical calculations, the reliability of the resulting graph, and the quality of the conclusions presented when the team reports to the rest of the class. The evaluation instrument will be the Food Tracking Rubric

6. **Guest Speaker**

90 min If possible, bring in a member of the local or regional community food bank to speak to the class. Ask the guest speaker to address the question, "Who is hungry in my community and country?" The talk should focus on numbers (percentages of adults and children who are hungry).

Encourage students to bring in an item of canned food, so that the whole class can make a donation to the food bank.

Prior to the guest speaker, take a few minutes to share Background Information with students. You may want to make an overhead transparency so that students can better view the pie graphs.

Follow up with research done with the USDA Economics and Statistics web site.

Add a Performance Task for this Step

7. **Hook:** Open this lesson with the following questions: Where is hunger? Is there enough

360 min food available? Will there be enough food in the world to feed your children? What can you do to ensure that your children will not be hungry?

Activity: Hand out the Student Activity 3. Divide students into 5 teams and assign each team a region of the country (Northeast, Southwest, Midwest, Southwest, and Northwest). Direct students to research (Internet and library) the question, "How prevalent is hunger in your part of the country?" The degree of hunger will be defined as follows: major hunger problems - greater than 35% of population; minor hunger problems - 5 to 35% of population; slight hunger problems - .01 to 5% of population; and no hunger problems - less than .01 % of population.

Each team will produce a PowerPoint presentation to illustrate the hunger conditions in their assigned region.

Assessment: The evaluation instrument for part one of this lesson will be the Student Activity 3.

For part two of this lesson, divide students into 9 teams and this time assign each team a region of the world (North America, Latin America, Eastern Asia, Southern Asia, Europe, North Africa, South and Central Africa, Middle East and Southern Pacific - Oceania). The teams will each produce a color-coded map for their region identifying the locations of the different categories of hunger (major, minor, slight, and no hunger). Within this same team assignment, guide students toward researching and answering the following questions: How many calories does the average person in the U.S. consume per day? Additionally, find the average daily caloric intake per person in 10 different countries (including the U.S.) Each team should chart these results in a spreadsheet and create a bar graph showing the caloric intake for each of the 10 countries. Students should also answer, "How does the caloric intake in these 10 countries compare with the minimum caloric intake for the average person?" Finally, the team should calculate the percentage of minimum daily requirement reached by the average person in each of the ten countries. Students have several other discussion questions within their Student Activity 3 Handouts to discuss.

Conclusion: Through whole class discussion, answer the following questions: Are any of the percentages less than one? If so, how does this compare to the color-coded map of each team? Brainstorm reasons that some countries could be identified as a high percentage of hunger and still have an average daily caloric intake of 1 or greater? Estimate, as a class, what the population of the world will be like in 2025. Based on the average caloric needs that a variety of populations are currently using and the total

number of calories that are being produced in the world today, is there enough food to feed the people in the world in 2025? If so, at what caloric level? If not, what can we do to ensure that there is? Utilize Bob Tinker's population spreadsheet.
Assessment: Students will be graded on all of the components of their team work: completeness (amount of research), reliability of their content (verification of information), clarity (material that is easily understood - including their notes), accuracy (of calculations), and insight (their level of understanding when interpreting data and drawing conclusions). The evaluation instruments will be the Student Activity 3, PowerPoint Rubric, and the Team Investigations Rubric.

Add a Performance Task for this Step

8.
300 min **Hook:** Introduce the KWLPart1 chart and the KWLPart 2 chart. Explain how a KWL chart works and tell students that they will be working within groups to research the questions in the W column.
Activity: Hand out the Student Activity 4 sheet after assigning students to groups. Also, assign each group a different country. You might want to review the activities listed in the Student Activity 4 Handout, but basically, the student will first complete what they already know (in the K column), and research the answers to the questions in the W column (through Internet and library usage). The results of the research will be recorded in the L column. All research focuses only on the one country assigned to the group.
Instruct each group to present their findings via a PowerPoint slide show presentation. Using their completed KWL charts, students will include maps, data tables, narrative talking points, and other references to illustrate the relationship between hunger and food production in their assigned country.
Assessment: Students will be assessed on the completeness of their research, the reliability of their gathered data, the insight their conclusions show, the accuracy of the text on their slides, and the overall quality of their slide show presentation.
The assessment instrument will be the Food Production Slide Show Rubric.

Add a Performance Task for this Step

9.
300 min **Introduction:** Review the video shown earlier in the unit, "40,000 a Day."
Activity: Present a lecture on "The Requirements for a Sustainable Food System." See the Guidelines for a Sustainable Food System for the material needed for the lecture. While you are giving the lecture, students will be taking 2-Column notes, answering the four key questions from the lecture (listed in the left-hand column) by responding in the right-hand column. Point out to students that the answers to the 4 questions also constitute the requirements for a sustainable food system and provide an example of a practical application.
Assessment: The assessment for this lecture, as well as a unit assessment, will be a performance objective in the form of a product. Students (within groups) will build a model of a sustainable community for the country they have been studying, or one which is selected or assigned, using two software programs entitled "Model-It" and "What If Builder." Products will be shared with other classes in the school, at school open house events, etc.

Add a Performance Task for this Step

10. Administer the Pre Post Test
60 min

View Performance Tasks for this Step
Add a Performance Task for this Step

1540 min **Total Estimated Time**

Additional Online Resources For Educators

The following is a list of websites that provide more information on energy & environmental education for K-12 classrooms.

A Child's Place in the Environment (ACPE) Series

An integrated hands-on environmental education curriculum with children's literature connections for K-6 teachers.

From the website: "*ACPE* is a series of six environmental education curriculum guides for elementary school teachers that integrates science, English-language arts, and selected children's literature, and culminate with student projects which enhance their environment and provide experiences in service learning. All of the lessons in each unit have been correlated to California's content standards in science and English-language arts. Students' pages in Spanish are available."

http://www.acpe.lake.k12.ca.us/

California Integrated Waste Management Board Classroom Curriculum

From the site: "The Board provides curriculum that offers accurate and current waste management information that encourages "reduce, reuse and recycle" in the classroom and home while making it exciting and interesting for both teachers and students."

http://www.ciwmb.ca.gov/Schools/Curriculum/default.htm

Environmental Education (EE) Link

This site is a project of the North American Association for Environmental Education (NAAEE) and contains a directory of information, projects, professional resources and classroom resources from across North America. Intended for educators.

http://www.nceet.snre.umich.edu/classroomresources-directories.html

Energy Education Resources for Parents and Teachers – California Energy Commission

This is the CEC's main site for energy education. Contains many environmental education materials and resources for parents and educators, including the CEC lesson plans, kid's sites, and games listed in this booklet.

http://www.energy.ca.gov/education/resources/index.html

California Department of Education's Environmental Education Website

California's Department of Education site has links to various EE information and resources as well as contact information for state officials dealing with environmental education. Also includes State Department of Education grant opportunities and instructions when available. A great resource with lots of information and links.

http://www.cde.ca.gov/cilbranch/oee/

Education Planet's Environment Page

Vast array of educator-approved resources and services. Extensive search engine allows you to search over 16,000 online lesson plans by keyword and grade.

http://www.educationplanet.com/search/Environment

CREEC.org – California Regional Environmental Education Community

Lists environmental education information, curriculum, and resources for teachers and students. Organized by region to give the most pertinent information for our area. You can also perform a search of the state's environmental education resource directory to find particular items.

http://www.creec.org/

ESF: Education for a Sustainable Future

A vast network of resources for educators interested in teaching about sustainability. Contains curriculum, contacts, news, and a small store. Developed by Cobb County Schools in Marietta, Georgia under funding from the US Department of Education. Contains the several comprehensive lesson, all with a focus on sustainability.

From the website: "Sustainable development addresses a group of critical issues that everyone must understand if we are to create the environmental, economic, and social cooperation society needs to move into the 21st century and beyond. Graduates of our schools must be better prepared with the skills and attitudes needed for satisfying and rewarding employment, must have a greater appreciation of the trends and developments that will impact their lives and their progenies', and must be more involved in shaping their communities. Sustainable development issues are urgently needed in the Nation's schools and, because they help students understand their futures, are inherently very interesting and motivating."

http://csf.concord.org/esf/

Glossary of Energy Related Terms

Active solar heating system: special mechanical equipment (such as solar collectors) is used to collect and distribute solar energy for home heating.

Air infiltration: air seepage due to wind drafts. Air pressure pushes cold air in through tiny openings on the windy side and draws heated air out of the opposite side of the house.

Air lock entry: a porch, vestibule, or entry hall with an inner door and an outer door at the entrance of a house or building. The two doors save energy by cutting down on air exchange when people go in or out.

Barrel: a liquid volume equal to 42 gallons or 159 liters. One barrel of crude oil has about the same heat energy as 448 pounds of bituminous coal, 5,600,000 Btu, or 1,410,579 kilocalories.

Biomass: any organic substance that can be used as an energy source. The most common examples of biomass are wood, crops, seaweed, and animal wastes.

Btu: British thermal unit, a unit for measuring heat energy; Btu is the quantity of heat necessary to raise the temperature of one pound of water one degree Fahrenheit, about one-fourth of a kilocalorie (252 calories).

Calorie: (also: gram calorie) a unit of heat energy; the amount of heat needed to raise the temperature of one gram of water one Celsius degree. It equals 0.00397 Btu.

Caulk: a soft, semi-solid material that can be squeezed into non-movable joints and cracks of a building, thereby reducing the flow of air into and out of the building.

Chemical energy: the energy released when substances combine or break down and form new substances.

Clock thermostat: a thermostat equipped with a timer to change temperature levels automatically at certain times of day.

Combustion: the process of burning a fuel to release heat energy.

Condensation: beads of moisture that form on surfaces as warm, moist air is cooled.

Conduction: passage of heat through a material. Some materials, like glass and metal, conduct heat (and lose it) easily. Insulation helps to block conduction of heat. If ceilings and walls are poorly insulated, they conduct heat from the house to outside.

Convection: transfer of heat by movement of air. As heated air contacts cold surfaces such as windows, it loses heat. The cooled air is denser than warm air, so it tends to settle, pushing warm air toward the ceiling. These temperature changes and air movements form a pattern. Warm, light air from the ceiling area is chilled along the window, becomes heavier and drops to the floor. It moves across the floor, is reheated, moves up the opposite wall, (away from the window), across the ceiling and down past the window again. Each cycle the air loses heat. Heat must be supplied from a sunny window, a furnace, stove, or other heater to maintain a comfortable temperature.

Conversion: the changing of a substance or the energy in it from one form to another.

Conversion efficiency: the percentage of usable energy that is left after an energy conversion. Efficiency = (Energy output / Energy input) x 100

Conversion loss: the amount of energy lost in the changing of one form of energy to another form. Much of this energy loss is in the form of waste heat.

Damper: a trapdoor or other device which controls the passage of air through a duct, chimney, or stovepipe.

Economic efficiency: getting the most benefit from all of our scarce productive resources.

Electrical energy: energy in the form of a flow of electrons that can be produced by chemical activity in a battery, by friction, or by generators. Electrical energy can be transformed to other forms of energy such as light, heat, mechanical, or sound.

Energy: the ability to do work or make things move. Energy exists in a variety of forms (electrical, mechanical, gravitational, light, nuclear, chemical, heat or thermal) and can be converted from one to another. Common units for measuring energy are calories, joules, Btu, and kilowatt-hours.

Energy conservation: actions taken to get the most benefit from our scarce energy resources; promotes energy efficiency.

Energy conversion device: a machine or object that changes one form of energy to another form.

Energy efficiency: the amount of energy it takes to do a certain amount of work. Also, getting the greatest benefit from our energy resources. Efficiency = (Energy output / Energy input) x 100

Ethanol: a liquid, biomass fuel derived from crops, such as corn and wheat; ethyl alcohol.

Flow restrictor: a device attached to a water nozzle or shower head to reduce the flow of water while maintaining the pressure of the spray. This saves energy by cutting down on the amount of hot water being used.

Fossil fuels: coal, oil, and natural gas. This term applies to any fuels formed from the fossil remains of organic materials (plants and animals) that have been buried for millions of years.

Fossil fuel powered electric generating plant: a building in which electricity is produced by burning fossil fuels to make steam which powers the generator. steam which powers the generator.

Fuel: any substance that can be burned to produce heat. (With nuclear energy, a substance that undergoes fission in a chain reaction to produce heat.)

Fuel cell: a device that changes the energy in fossil fuels to electricity.

Gasohol: biomass fuel produced by mixing ethanol and gasoline, typically 10 percent and 90 percent respectively.

Geothermal energy: energy that comes from the heat within the earth. There is more than one kind of geothermal energy, but the only kind that is widely used is hydrothermal energy.

Hydropower: energy that comes from the force of moving water. Hydropower is a renewable energy source but can have negative impacts on the environment.

Hydrothermal energy: most common type of geothermal energy; produced when water beneath the earth's surface contacts heated rocks and changes into steam. The steam can heat buildings directly or can power turbines to generate electricity.

Insulation: material with high resistance (R-value) to heat flow used to prevent heat loss. The resistance to heat flow is provided by the many small dead air spaces between the fibers or particles. Some commonly used materials for home insulation are fiberglass, cellulose, rock wool, and styrofoam.

Kilocalorie: (kcal) a unit of heat energy equal to 1,000 calories, sometimes called a Calorie or food Calorie.

Kilowatt: a measure of power, usually electrical power or heat flow; equal to 1,000 watts or 3,413 Btu per hour.

Kilowatt-hour: (kWh) the amount of energy equivalent to one kilowatt of power being used for one hour; equal 3,413 Btu, or 860 kcal.

Market Price: price of a good, service, or energy resource, as determined by its price in the marketplace.

Mechanical energy: energy due to the motion of an object. Example: the energy of the moving parts of an automobile engine.

Methane: colorless, odorless gas formed from the decay of organic substances; identical to natural gas.

Methanol: a liquid, alcohol fuel derived from wood, agricultural wastes, coal, and natural gas; methyl alcohol.

Nonrenewable energy sources: finite sources of energy that will eventually run out. Examples are fossil fuels such as coal, petroleum, and natural gas.

Nuclear energy: energy from radioactive decay or from fission or fusion reactions. In a controlled situation it can be used to produce electricity.

Nuclear fuel: material containing atoms whose nuclei split or undergo fission, producing heat energy.

Nuclear powered electric generating plant: a building in which electricity is produced by using the heat given off by nuclear fuel in a controlled chain reaction to make electricity.

Ocean thermal energy conversion (OTEC): a form of hydropower which uses the temperature difference between surface and deep ocean waters to boil and then recondense fluids.

OPEC: stands for Organization of Petroleum Exporting Countries, a cartel that controls a large part of the world's oil reserves.

Opportunity Cost: the value of the next best alternative that is passed up when making a decision; every decision has an opportunity cost.

Passive solar heating system: heating system where a home's design lets in large amounts of sunlight. The heat produced from the light is trapped inside. A passive solar heating system does not rely on special mechanical equipment to produce heat.

Photosynthesis: the process by which green plants use solar energy to convert simple substances into complex ones which contain chemical energy. Carbon dioxide and water are combined, in the presence of sunlight and chlorophyll, into carbohydrates such as sugars, starches, and cellulose.

Primary energy sources: direct sources of energy, including petroleum, coal, natural gas, hydropower, propane, geothermal, wind, solar, and biomass. Primary energy sources are classified as renewable or nonrenewable.

Profit: the amount of sales revenues remaining after subtracting all the costs of production.

Quad: One quadrillion (1,000,000,000,000,000) Btu's.

R&D: stands for research and development.

R-value: the factor which tells how much resistance to heat flow a material has. The higher the R-value, the greater the insulating efficiency of the material. R-values are commonly stated per inch of building material. R-values are additive - thicker material or a combination of materials means increased resistance to heat flow.

R-value standards for an efficient house: Ceiling: R-33; Exterior Wall: R-19; Floor: R-22.

Radiation: passage of energy through open space, like sunlight. During the daytime a building absorbs solar radiation, but after the sun goes down, it starts to reradiate heat to the cold outside air unless something is done to block the radiation.

Renewable energy sources: sources of energy that are considered "unlimited" in supply because they can be replenished quickly or are nondepletable. Examples include solar, hydropower, wind, geothermal, and biomass.

Roof overhang: a solid horizontal or angled projection on the exterior of a building placed (ideally) so that it shades southern windows in summer only, when the sun is high in the sky. This saves on air-conditioning.

Secondary energy source: a source of energy that requires primary sources to produce, for example, electricity. Unlike the primary sources, electricity is not classified as renewable or nonrenewable.

Scarcity: in economics, this situation that exists whenever wants are greater than the resources available to satisfy the wants; scarcity requires people to make choices.

Solar cell: a device that changes sunlight to electricity. Also known as a photovoltaic (PV) cell.

Solar energy: energy in the form of radiation emitted by the sun. The earth receives this energy mostly in the forms of heat and light.

Subsidy: financial assistance given by government to encourage the production of a good, service, or resource; production would be uneconomical without the subsidy.

Solar thermal systems: large collectors concentrate the sunlight onto a receiver to superheat a liquid, which is used to make steam to power electrical generators.

Therm: a unit of measure of the heat energy in 100 cubic feet of natural gas. Equal to 100,000 Btu.

Thermal energy: heat energy; the energy of moving particles within a solid, liquid, or gas.

Vapor barrier: a waterproof liner used to prevent passage of moisture through the building structure. Vapor barriers in walls and ceilings should be located on the heated (indoor) surface of the building. Some insulations come with a vapor barrier attached.

Waste-to-Energy Plant: a plant that burns solid waste to produce usable energy

Watt: a small measure of power, usually electrical power or heat flow; equal to 3.143 Btu per hour. One horsepower =746 watts.

Weather-stripping: material which reduces the rate of air infiltration around doors and windows. It is applied to the frames to form a seal with the moving parts when they are closed.

Wind energy: energy that comes from the movement of air. Using a turbine, energy is produced by converting the wind's kinetic (motion) energy into mechanical energy for grinding grain, pumping water, or producing electricity.

Windbreak: a dense row of trees, or a fence or other barrier that interrupts and changes the local path of the wind. Windbreaks located on the north and west sides of a building can save heat by reducing wind chill and air filtration.

Window treatments: applications to the interior side of windows (blinds, shades, shutters, draperies), used to save energy by keeping heat in or out.