DOCUMENT RESUME

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TITLE	Lessons from an Energy Curriculum for the Senior High Grades. Unit VIII - Energy Measurement. Energy Education Curriculum Project.
INSTITUTION	Indiana State Dept. of Commerce, Indianapolis. Energy Group.; Indiana State Dept. of Public Instruction, Indianapolis. Div. of Curriculum.
SPONS AGENCY	Department of Energy, Washington, D.C.
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DESCRIPTORS	*Building Design; *Conservation Education; Energy; *Energy Conservation; Environmental Education; High Schools; Interdisciplinary Approach; *Learning Activities; *Physical Sciences; Science Activities; Science Curriculum; Science Education; *Secondary School Curriculum; Teaching Guides; Units of Study
IDENTIFIERS	*Energy Education; Indiana; Thermostats

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Energy education units (consisting of a general teacher's guide and nine units containing a wide variety of energy lessons, resources, learning aids, and bibliography) were developed for the Indiana Energy Education Program from existing energy education materials. The units were designed to serve as an entire curriculum, resource document, supplementary materials, or as a laboratory manual of "hands-on" activities which could be infused into existing grades 9-12 curricula. Unit VIII, focusing on energy measurement, consists of an introduction (rationale, unit objectives, general background information); three lessons, bibliography, and teacher evaluation form. Each lesson includes lesson title, objectives, background information, activities, evaluation techniques, and resources. Titles of lessons are: (1) The Bimetallic Robot; (2) Make Room(s) for Energy; and (3) A Do-It-Yourself Home Insulation Test. Students design, construct, and test their own thermostats in the first lesson, design and draw a house using energy conserving and energy conscious approaches in the second lesson, and complete an insulation audit in the third lesson. (Author/JN)

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LESSONS FROM AN ENERGY CURRICULUM FOR THE SENIOR HIGH GRADES

Unit VIII: Energy Measurement

Division of Energy Policy
Indiana Department of Commerce
Lt. Governor John M. Mutz, Director

Division of Curriculum
Indiana Department of Public Instruction
Harold H. Negley, Superintendent

April 1982

FOREWORD

Indiana educators have always responded to the demands placed upon them by society to resolve natural and human resource issues and problems. The task of teaching energy concepts and conservation practices to Indiana's youth is a response to energy problems facing our state and nation. It will be accomplished by many high school teachers and students getting involved in energy education.

We feel that students of all ages must be taught an energy conservation ethic. This ethic will enable each student to use Indiana's and America's energy resources more efficiently and with less waste. To help high school teachers accomplish this major goal, we are pleased to introduce a new Senior High School Energy Education Curriculum. This exciting and innovative program contains energy education activities, programs and resources for you and your students.

We encourage you and your students to get involved in the lessons presented here. We hope you will use these materials as a starting point and go far beyond by involving other classroom teachers, students, resource agencies and citizens in your community. A broad educational effort is needed to help prepare students to deal with this growing issue which affects us all.

Harold H. Negley
State Superintendent of
Public Instruction

John M. Mutz
Lieutenant Governor
State of Indiana

ACKNOWLEDGMENTS

The Energy Education Curriculum Project is coordinated by the Indiana Department of Public Instruction, Division of Curriculum, with the support and assistance of the Indiana Department of Commerce, Division of Energy Policy.

These materials, from the senior high grades Energy Education Curriculum Project (EECP), were adopted from existing national energy education programs. The materials were selected by the EECP staff with assistance and direction from a Review Panel and the Energy Education Steering Committee.

George Cannon, Patricia Shutt and Joe Wright, Energy Education Consultants, coordinated and supervised the preparation, evaluation and dissemination of these energy education materials. Carol Wood, Teacher Associate, assisted the EECP staff with the design and dissemination plans for the materials.

Members of the Senior High Energy Education Steering Committee are -- John A. Harrold, Director of the Division of Curriculum; Darrell Morken, Director of the Division of Traffic Safety; Gary Geswein, Vocational Agriculture Consultant; Jerry Colglazier, Science Consultant; Joyce Konzelman, Home Economics Consultant; Jane Lowrie, Social Studies Consultant; Victor Smith, Research and Evaluation Coordinator; Gregg Steele, Industrial Arts Consultant.

Clarence Broadus, Director, and Michael Hennegan, Residential/Education Coordinator, Division of Energy Policy offered suggestions and comments which helped to improve the materials.

The materials included in this unit of the senior high segment of the Energy Education Curriculum Project (EECP) were adopted with permission from:

The Minnesota Trial Test Materials
Minnesota Department of Education
625 Capitol Square Building
St. Paul, Minnesota 55101

Developer of Minnesota Program
Tom Ryerson - Supervisor
Industrial Education

This material was prepared with the support of the U.S. Department of Energy (DOE) Grant No. DE-F645-76CS 60038. However, any opinions, findings, conclusions, or recommendations expressed herein are those of the author(s) and do not necessarily reflect the views of DOE.

Unit VIII

Table of Contents

INTRODUCTION
(Rationale)

ENERGY EDUCATION - WHAT IT IS -- Past, Present, Future

Energy education is the attempt to resolve the conflict between our present life style and the energy costs in both dollars and resources to produce and maintain that life style.

Energy education is reality education in that it deals with that which exists here and now.

But, energy education is also a study of futuristics. The future that all of us must be willing to live in and accept is the one that we are creating right now by our daily decisions. We must examine the beliefs that "growth is good" and "bigger is better" and determine the impact these beliefs will have on our future.

Energy educators interested in the challenge to teach students about local, state, national and global energy resources, problems and issues should consider the the following questions:

1. Can you help prepare your students to make wise and careful decisions about our remaining non-renewable energy resources?

2. Can you help prepare them to investigate and make wise decisions about research and development efforts for alternate and renewable resources, recycling programs, more efficient transportation systems, better personal consumption habits, and a personal committment to efficient energy usage?

3. Can you explain to your classes where energy comes from, what the basic sources of energy are, how long our non-renewable energy resources will last, and the energy options among which our nation's people must choose if we are to survive.

As the three questions above suggest, energy education is a challenge which encompasses all facets of living. Energy education is an opportunity for students to have impact on a long-lived problem, an opportunity to apply traditional content and skills to an important problem situation, and an opportunity for students to participate in personal and social decisions.

WHY STUDY ENERGY?

"One of the best ways to deal with a crisis is to consider it as an opportunity: From this point of view, the Energy Crisis provides almost endless possibilities for children to learn about themselves. Energy after all is what makes all things go. We need to realize that the energy crisis isn't just the newest fad. By studying the energy crisis, students can see where humanity has been, where it is now, and where it might be going. The energy crisis is another chapter in the story of mankind's continuing effort to reshape the world and the inevitable cost of doing that."[1]

To insure proper utilization of energy sources, our society must be educated about alternate life styles, energy resources, technology, consumer behavior and occupations.

The Indiana Department of Public Instruction, in cooperation with the Department of Commerce, Division of Energy Policy, has organized the Energy Education Curriculum Project (EECP) to meet the challenge of educating young people (our future adults) about energy, the energy crisis and the role they can play to help conserve America's economy and resources.

One way the Energy Education Curriculum Project staff has dealt with the task of disseminating energy information and education is through the Indiana Energy Curriculum Units. The units have been organized to help provide educators in many areas with lessons, charts, materials and "hands-on" activities to be used in the classroom.

[1]Kuhn, David J., "Teaching the Energy Lesson," in the Science Teacher, September 1978.

The Curriculum - Background Information

The Energy Education Units contained in the Senior High School materials were adopted from existing national energy education materials. A team of teachers from Indiana reviewed and evaluated energy documents from across the nation. After thoroughly reviewing the materials, only those activities or lessons which proved to be most effective in educating students were chosen for Indiana's program.

The units are designed to be used as the individual teacher wishes. The energy units could be used as an entire curriculum or as a resource document, supplement or laboratory manual of "hands-on" activities which can be infused into already existing curricula.

The Indiana Energy Education materials for grades 9-12 consist of a Teacher Guide, nine units containing a wide variety of energy lessons, resources, learning aids and a bibliography.

Unit VIII:

Unit VIII consists of a series of activities, charts and graphs which provide students with energy measurement skills.

Unit Objective:

Upon completion of this unit the student will become familiar with the operation of the thermostat, and the IC centigrade thermometer and their constructions.

Unit VIII

Energy Measurement: Student Activity

Lessons A-B-C

Note: The lessons that follow can be infused into an already existing curriculum. It is hoped that the teacher will incorporate these activities in the most beneficial manner.

LESSON TITLE: "The Bimetallic Robot"

LESSON OBJECTIVE:

Students will design, construct and test their own thermostats as well as use the principle of a thermostat to make a temperature change indicator.

BACKGROUND INFORMATION

Most metals expand when heated. Some common examples of the expansion of metals include mercury thermometers, the need for expansion gaps in bridges and the bolted rails or railway lines, and loosening tight metal screw caps by holding them in hot water.

Different metals do not expand by the same amount and if two pieces of different flat metal strips are fastened together they bend when they are heated and cooled. Bimetallic strips are found in thermostats used to control the central heating systems of buildings. A thermostat is a heat controlled switch.

ACTIVITIES

Activity 1

Have students connect the following circuit (Be sure you don't connect the wires to mounting screws):

Figure 1: A thermostat circuit.

Test Procedure

1. Read the temperature of the thermostat indicator or thermometer.

   Temperature = ________ °F

   Is the thermostat accurate? How do/can you know?

2. Place thermostat in a vertical position. Adjust set dial at lowest temperature setting. Adjust the set dial until the lamp goes on. At what temperature does it go on?

   Temperature = ________ °F

3. Observe the inside of the thermostat and answer the following questions:

CHECK YOURSELF: (Circle the correct answer)

1. How many wires go to the thermostat?

   A. One
   B. Two
   C. Three

2. The "spring like" device is a

   A. Single metallic strip
   B. Bi-(two) metallic strip

3. When the thermostat gets hotter, the spring gets

   A. Tighter
   B. Looser

4. When the temperature of the room is <u>higher</u> than the thermostat setting the points are

   A. Open
   B. Closed

5. Which surface expands the most?

   A. Top of the strip
   B. Bottom of the strip

   How do you know? ______________________________

   ____

<u>Materials list</u>

1 - Thermostat Honeywell <u>T87F</u> or equivalent
1 - 1½ Volt cell
1 - #222 lamp or equivalent flashlight lamp
1 - Thermometer

<u>Activity 2</u>

Challenge your students to make their own bimetallic strips. Students can use screws/pop rivets/epoxy glue to bond two different metals.

<u>Activity 3</u>

Challenge your students to test their homemade thermostat and prove to you that it works. If they place a candle under one end of the strip, what happens?

Activity 4

Ask your students to respond in writing and orally to the questions below:

1. Is a thermostat a thermometer? Explain.

2. In what way is a thermostat an energy-saving device? What are its advantages? Are there any disadvantages? If there are disadvantages, what can be done about them?

3. The title of this activity refers to thermostats as robots. What is meant by this?

Materials list

Screws
Pop rivets
Epoxy glue
Assorted metals, e.g., iron, brass, zinc, copper, aluminum (pie plate), tin can tops
Assorted pieces of wood for construction supports
D-Cells
Metal snips
Copper connecting wire
Small light bulbs
Nails
Bell/buzzer
Candles
Ice Cubes

RESOURCES:

The Minnesota Trial Test Materials
Minnesota Department of Education
625 Capitol Square Building
St. Paul, Minnesota 55101

Developer of Minnesota Program
Tom Ryerson - Supervisor
Industrial Education

Cobb, Hubbard H. 1979. "WD $$-Saver Report of Home Thermostats." Woman's Day. November, pp. 36, 38, 40.

Dyrli, Odvard Egil. 1979. "Use 3-by-5 Cards to Get Kids Thinking." Learning. April, pp. 62, 63, 65 (Available in most school learning centers, especially K-8).

Oak Ridge Associated Universities. "Science Activities in Energy." 1977. Conservation. Two of the 14 activities in this packet are bimetallic strip construction and testing projects. Each has detailed drawings. They are designed for upper elementary students. (Copies of the materials may already be available in your school. They may also be ordered from: U.S. Department of Energy, Technical Information Center, P.O. Box 62, Oak Ridge, TN 37830).

LESSON TITLE: "Make Room(s) for Energy"

LESSON OBJECTIVE:

This unit makes use of two approaches to design: energy CONSERVING design and energy CONSCIOUS design. Students will design and draw a house which combines these approaches.

BACKGROUND INFORMATION

"Let all the principal chambers of Delight, All Studies and Libraries, be towards the East. For the Morning is a friend to the Muses. All Offices that require heat, as Kitchins, Stillatories, Stoves, rooms for Baking, Brewing, Washing, or the like, would be Meridionall. All that need a coole and fresh temper, as Cellers, Pantries, Butteries, Granaries, to the North,..."

The Elements of Architecture
Sir Henry Wooton, 1624

Housing is a major consumer of energy in the United States. A number of studies have been made on the problem of reducing the amount of energy consumed by our housing stock. Many of these suggest that a 25% to 35% reduction in heating expenses is possible by making fundamental construction improvements, e.g., upgrading insulation, adding weatherstripping and double glazing, and by being careful in the use of energy, e.g., by setting thermostats at 65°F.

These 25%-30% savings can be significantly extended if one is willing to go beyond the "fundamental construction improvements" listed above. This requires that the architect/builder/designer understand natural energies such as the sun and wind, and be able to respond to them, through passive design, during planning, design and construction.

In a recent publication of The National Heating and Cooling Information Center two approaches to design were distinguished: energy CONSERVING design and energy CONSCIOUS design.

An energy CONSERVING house exhibits standard-practice, energy conserving construction characteristics such as good insulation, quality weatherstripping, and insulated glass or storm windows and doors. Any good builder who is abreast of current trends can build an energy-conserving house.

The energy CONSCIOUS house, on the other hand, provides ADDITIONAL energy conservation by incorporating passive design ideas, and by using solar energy through passive systems, in its planning, design, construction and use. Building location, siting, orientation, configuration, layout, construction, mechanical and electrical systems, casework, and interior furnishing are all carefully evaluated in terms of their contribution to energy consumption and conservation. Natural energies are used to their fullest.[1]

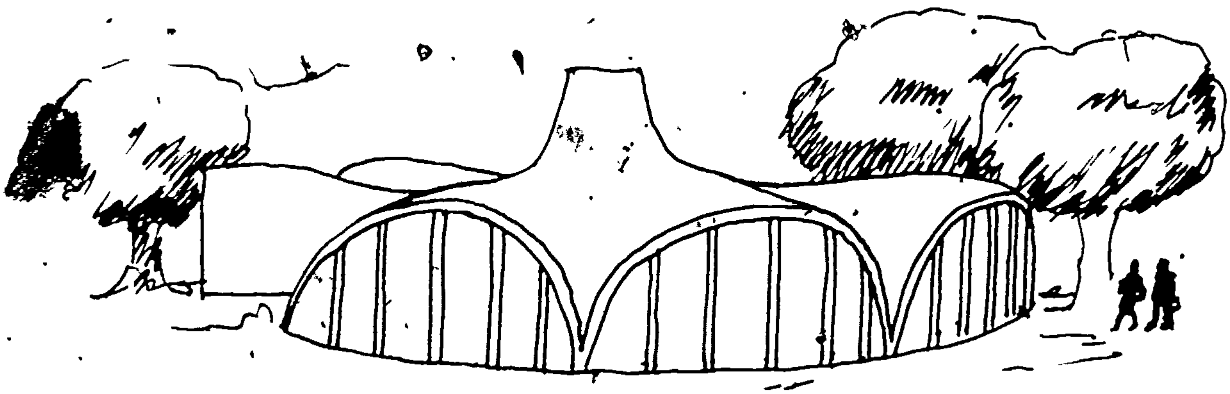
[1] Walter Kroner and David Haviland, "Passive Design Ideas for the Energy Conscious Architect," 1978, p. 3.

ACTIVITIES

This unit assumes that you have taught/are teaching basic architecture, drawing and design concepts and skills. It also assumes that you may have considered/are considering some energy CONSERVING design and energy CONSCIOUS design principles with your class (see background). Some of these include principles of insulation, passive solar collectors - windows and walls, earth berming, underground houses, building orientation for solar and climatic gain, etc.

The activity also makes an assumption about the meaning of alternate housing. The real alternative in housing that you are asked to emphasize with students is CONSERVATION. It does not require major technological breakthroughs, big technologies, major changes in the way we live, a repressive society or whatever else is imagined when conservation is mentioned.

It requires, as some architects and designers express it, cleverer buildings. The TOP PRIORITY IN THE PLANNING, DESIGN, CONSTRUCTION, AND USE OF BUILDINGS SHOULD BE TO MINIMIZE HEAT LOSS IN THE WINTERTIME AND HEAT GAIN IN THE SUMMER.



Alternate Housing I: The So-Called Unconventional

For many, the mention of the idea of alternative housing refers only to unconventional structures. Some examples of more-or-less unconventional homes include: Yurts, Tipis, Bioshelters, Cement, Tao Foam, Free Form, Silo, Dome, Zome, Underground, Ferro-Cement, Zardi, Hypar, Red Rocker, Junk Building, Found Built . . .

Many of these shelters are the products of do-it-yourself housebuilders where there is great emphasis on being in complete control of the housing environment and an emphasis on personal autonomy. Many of these housing types represent important although often highly personal experiments. They are answers to environmental questions: Is there a way to live and walk more gently on the earth? In a time of resource scarcity, short supplies of fuels and ever increasing housing prices, are there options that we have not even imagined or, perhaps, dared to imagine?

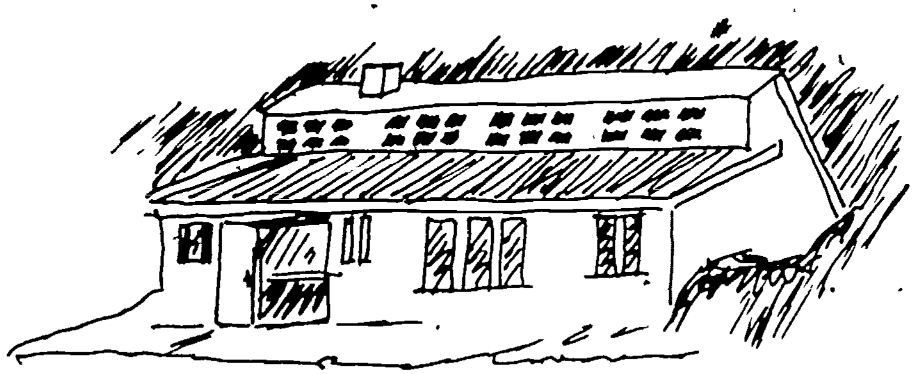
Some of the shelters also represent a revival of interest in hand-work and the hand-made: What is the best balance between the machine-made and the hand-made?

Alternate Housing II: The So-Called Conventional

Because the alternate in housing emphasized in this activity is conservation, the so-called conventional house is also included as an alternative possibility. There are many reasons for this, although two seem to be the most important:

1. Conventional stud construction of a small house is often the quickest, cheapest and most durable way to build.

2. Building a well-insulated, energy conserving small house can save more energy than buying new, expensive hardware.



Alternate Housing III: The Energy Conserving-Energy Conscious House

Some characteristics of an energy conserving-energy conscious house which integrates a number of passive design ideas have been suggested by Walter Kroner and David Haviland of the Center for Architectural Research at Rensselaer Polytechnic Institute, Troy, New York. The passive design ideas used in a house which totals 1,646 square feet of floor area plus 182 square feet of unheated atrium space are:

Volumetric Configuration
- 1-story residence
- 7' exterior walls
- roof slopes to a peak of 10'-7"
- basement height to bottom of joists, 7'-8"

Plan Configuration
- Square floor plan with an atrium
- Compact circulation area allows addition of bedroom

Earth Insulation
- Partial berming to window sill (north and south wall)
- Berming nearly to the roof eave (north and east wall)

Wall Composition
- White asphalt shingles, underside of roof is exposed to interior and contains R-33 insulation
- Roof sheathing has reflective surface against interior air space

Atrium/Greenhouse
- As a secondary skin, effectively raising the temperature just outside the building's exterior wall in the winter and, if plants and shading devices are used, lowering it in the summer
- As a passive solar collector

Entry Locks
- Entries enclosed so that both doors are not generally open at the same time

Windows
- Wood frame sash
- Insulated glass, double and triple glazing

Operable Roof Components
- Skylight in atrium has operable section for natural ventilation
- Upper portions of interior walls have manually operated vents for through ventilation

Partitioning
- Interior partitions between zones have R-11 insulation
- Flexible wall partitions are utilized in living and dining rooms to provide zone control

Hot Water Heating
- Individualized domestic hot water heaters are utilized

Alternative HVAC Systems
- Individual zones are utilized with clock thermostats programmed to a set schedule

Orientation
- For solar gain: for passive solar collection, southfacing glass should be 1/4 to 1/5 of the floor area (temperate climates) or 1/3 to 1/4 of the floor area (colder climates)
- For natural ventilation: locate the facade through which breezes enter at an angle of 20° to 70° between wall and wind direction

Closets
- Located against exterior walls

Background Data

Exterior walls are constructed of 2x4 and 2x6 (in bermed areas) members.

Floors are framed with 2x10 members.

Roof is framed with 2x12 members; has a 2:12 slope and a 3'-0" overhang with adjustable louvers on all sides.

Atrium is covered with a skylight, and a canvas shade to reduce heat gain when this is desired.

Exterior doors are solid wood core with storm doors; windows are wood sash with storms (slightly less window area than Standard Practice House).

House is zoned into three sectors. Use pattern is as shown under 'heating energy' below. Temperature maintained at 70°F during 'occupied' times and 55°F at other times.

House includes operable shutters (U value: .115) which are open from 8 a.m. to 4 p.m. in the wintertime. Summer schedule for shutters on east windows is 1 p.m. to 4 p.m.; shutters on south windows, 7 a.m. to 9 a.m. and 3 p.m. to 5 p.m.; west windows, 8 a.m. to 11 a.m.; north windows, 8 a.m. to 7 p.m.

Additional energy conservation ideas are included in Appendix II. The Resources section also includes reference materials you may find useful.

Activity 1.

After you have reviewed energy conservation and the passive design ideas included in this material with your students, challenge them to design an energy-conscious house. It must meet these qualifications:

1. Minimize winter heat loss.

2. Minimize summer heat gain.

3. Make use of natural energies such as solar radiation and prevailing winds through passive means.

4. Where possible, make use of active, renewable energy souces.

5. Tend to be low in cost and economical.

6. Can be built using current technology by today's home-building industry and within today's regulations.

7. Does not require radical changes in lifestyle or attitude on the part of the consumer.

8. Must meet the instructor's drawing and design standards.

Students can check out a proposed floor plan by drawing it with chalk on a schoolyard. It should include not only the interior partitions but also furniture and other appliances. Students can then walk around within it to get a feel for the design and spatial relationships.

Activity 2

1. It is sometimes said that cathedral ceilings are no longer desirable features in new homes. Ask your students whether they agree or disagree. Elicit some of their reasons. When are such ceilings an advantage? A disadvantage? Ask students to design (a simple sketch drawing) a solution to this problem, one that takes advantage of the cooling effect in the summer and which reduces the energy liability during the heating season.

2. As a result of your work in this project, use a design concept which would make your home more energy conserving and energy conscious. Check it out with the owner. Is it a possibility?

3. For an energy-conserving, energy-conscious house, where would you locate evergreen trees and deciduous trees? What are your reasons?

4. Ask students to complete the following sentences.

   Energy-conserving, energy-conscious architecture is ________

   ____

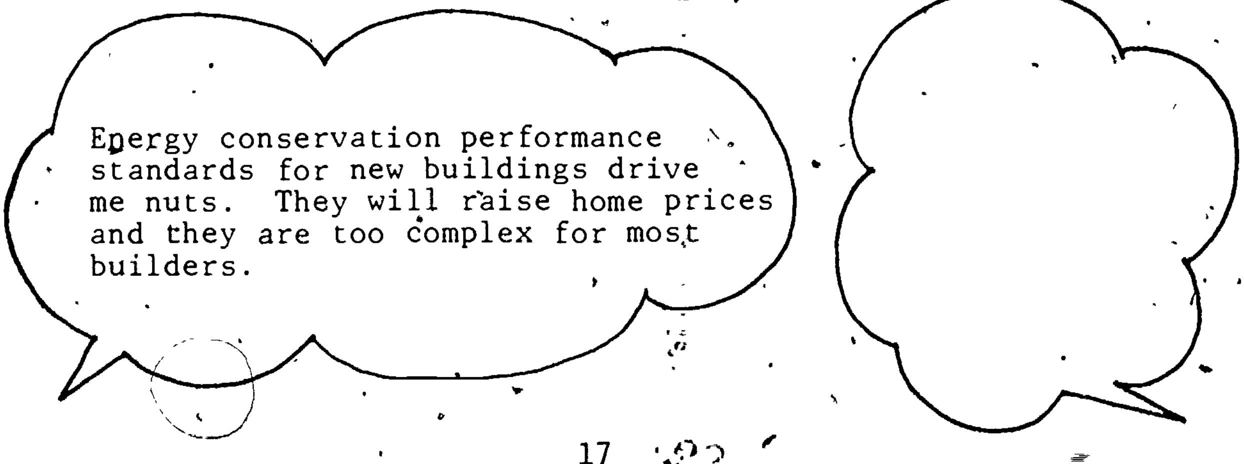
   I learned this about energy conservation and architecture

   ____

   In the future, I think houses will ________________

   ____

5. Ask students what they would say in response to the following situation.



APPENDIX

ENERGY CONSERVATION IDEAS: TERMS AND EXPLANATIONS

Caulking: Caulking is the process of applying a flexible putty--a high quality latex or butyl rubber caulk--to the exterior cracks of your home to prevent air infiltration through these cracks.

Attic Insulation: Attic insulation should be installed in all attic areas to the outside edge of exterior walls to a minimum R value of R-38 or even greater.

Entry Locks: Entry locks are enclosed entries--either as appendages or within the perimeter of the house--designed so that outside air cannot flow directly into homes when entering or leaving. This will reduce heat loss significantly. Entry locks have to be large enough so that it is not necessary to open both access doors.

Attic Openings: Attic access doors should be weatherstripped. In addition, the door should be insulated to a R-38 or greater value. Attic insulation should fit closely around pipes, flues and chimneys.

Attic Ventilation: Ventilation of attic and roof/ceiling spaces helps to lower air temperatures in these spaces in the summer. It also serves to allow moisture vapor to escape and thereby minimize wintertime condensation which lowers the R-value of attic insulation. Attic roof vents should be a minimum of one square foot of useable vent area for each 150 square feet of attic area.

Eave Insulation: A weakness in older construction has been the lack of room at the eaves over the walls for adequate insulation. A minimum of 14 inches between the roof and the top wall plate should be provided for insulation and air passageway.

Sill Sealer: Sill sealer is a fiberglass material which is placed between the footing and the sole or sill plate during construction. This material will reduce the air leakage or infiltration which would be considerable at this point without the sill sealer.

Wall Insulation: All exterior walls from the footing to the top sill should be designed so that they have a minimum insulation of R-19. This would amount to 6 inches of fiberglass or 4 inches of extruded styrofoam insulation.

Wall Corner Construction: Wall corner construction in the past has been designed so that insulation could not be installed into the corners and thus there was an uninsulated area which was a significant loss of house heat at this point. Corners should be designed so that they can be insulated against this source of heat loss.

Insulation Behind Pipes and Electrical Boxes: Walls should be constructed of 2x6 studs with pipes and electrical outlets placed so that insulation can be installed in the wall behand them. Space should be provided for insulation behind pipes and electrical boxes in all outside walls.

Crawl Space: Those buildings which have floor joints above ground level should have insulation installed under the floor to a R value of R-22 or greater and should also have polyethylene film installed on the ground.

Band Joist Insulation: The area between the first floor top plate and second floor bottom plate has an outside joist called a band joist. In insulating homes this is an area that is often overlooked. This area should be insulated to a minimum of R-19.

Slab-on-Grade: Slab-on-grade refers to those homes which have a concrete floor at approximately ground level. Slab floors should be insulated with a minimum of 2" of styrofoam insulation which extends in eight feet from all exterior walls.

Basement Walls: Basement walls should be insulated down to the footings and should have a minimum R value of R-10 for all areas underground. All basement walls above ground should be insulated to R-19 or greater.

Ducts: Ducts are rectangular pipes used to transmit heat from the forced air furnace to areas throughout the home. Where ducts must be placed outside insulated living space they should be insulated with a minimum of 3½" of fiberglass or equivalent insulation.

Grading and Backfilling: Grading is the term used to indicate the leveling of the ground around the outside of the building. The maximum amount of earth possible, placed on the exterior of the house, is desirable. Earth shelters the house from outside air temperatures and thus reduces your house heat loss.

Window Shading: Shading southern exposure glass with an overhang is an important method of reducing heat gain in the summer. Allowing the sun to strike the window glass during winter is desirable to maximize heat gain in the winter.

Passive Solar Design: Passive solar design utilizes the architectural design and the sun to capture, store, and distribute heat. A south facing window equipped with an insulated shutter and with an adequate heat storage mass represents a passive approach.

Windows on North, East and West Exposures: Windows are very energy inefficient and therefore are costly in terms of heat loss in the winter and air-conditioned loss in the summer. Therefore, a building should have fewer (some say no) windows on the north, east, and west walls.

Exterior Doors: Well fitting exterior wooden doors and storms have only a combined R value of less than R-4. Insulated steel doors with an R factor of R-15 or greater should be used on new buildings.

House Orientation: The house should be oriented with the longest wall facing south and with the maximum amount of windows on the south side so that the windows can be used as passive solar collectors in the winter.

Building Design: In an extremely cold climate, a building should have as compact a design as possible to reduce the amount of exposed wall area to outside air temperature. An example of a "minimum perimeter" house is a dome.

Ceiling Height: Reducing the wall height to 7 feet or 7 feet six inches will conserve energy for the simple reason that lower ceilings reduce the wall area.

Vapor Barriers: Walls, ceilings, and floors should be provided with a positive vapor barrier covering the entire surface, to prevent mosture from entering the insulation and reducing the insulating qualities of the insulation.

RESOURCES:

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LESSON TITLE: "A Do-It-Yourself Home Insulation Test"

LESSON OBJECTIVE:

On a cold winter night students will take some temperature measurements to help them decide whether a wall in their home requires added insulation. After they have completed these measurements, they will then perform a simple home insulation audit.

BACKGROUND INFORMATION

Why do people need to insulate their homes? Heat energy costs money. Save heat energy and you save money! The purpose of insulation is to reduce significantly the amount of heat that is lost from the home. The direct dollar savings - reductions in annual heating bills - are obvious.

The indirect dollar savings are less obvious. A study done for the Pacific Power and Light Company showed that a power plant of 394,000 kilowatts at a cost of $152 million would be needed by 1984 just to supply heating energy that is wasted in living units constructed during the 1974-1984 period. In addition to economics, there are also other important considerations. These include a reduction in the amount of pollutants (acid rain, nuclear wastes), less dependence on imported oil and environmental protection.

ACTIVITIES

Material Needed

1. Thermometers
2. Rulers
3. Measuring Tape
4. Cold winter evening

Activity 1

A Wall Audit

There is a simple check students can make to help them decide whether a wall in their home should have added insulation. Ask them to conduct the following wall test in several rooms.

1. Place a thermometer firmly on an inside surface of an exterior wall and another thermometer in the center of the room.

2. Allow the thermometer readings to stabilize. Record the temperatures of the center of the room and of the inside surface of the outside wall.

3. Subtract the outside wall temperature from the center of the room temperature. Record it.

   If the temperature difference is more than 5°F, you should consider adding wall insulation. Does this wall in your home appear to need more insulation?

4. Option. Do floor-to-ceiling temperature measurements of the center of the room and the inside surface of the outside wall. Take at lease three temperature measurements: bottom, middle and top. Record the findings and compare the results with a single measurement point.

Activity 2

A Simple Home Insulation Audit

Provide students with the following checklist and have them conduct an insulation audit of their home. This assignment may require the assistance of students' parents/guardians.

The checklist is based on fiberglass batts or blankets. Students may find other materials used in their homes. An insulation chart which compares some thermal properties of various insulating materials, per inch of thickness, is included in Appendix I. A list of definitions of common terms is included in Appendix II. Review these with your students.

1. Attic Insulation. If it is over 12 inches thick (R-38), score 6 points; if it is between 9 and 12 inches thick, score 4 points; if it is 6 inches thick, score 2 points; if it is less than 6 inches thick, score zero points.

   Score ____________

2. Wall insulation. If it is 6 inches (R-19), it is worth 4 points; 3½ inches thick (R-11), it is worth 2 points; less than 3½ inches, the score is zero.

   Score ____________

3. Basement or crawl space insulation. If it is 6 inches thick, score 3 points; if it is 3½ inches thick, score 2 points; if it is less, the score is zero.

   Score ____________

4. Attic ventilation. If over 1 square foot of ventilation per 100 square feet, score 3 points; if less than this, score 2 points; and if there is no attic ventilation, score zero points.

Score __________

Add up the points scored on each of the above insulation and ventilation items. If your score is 12 or above your home is well-insulated. If your score is 10 or above your home is marginally insulated. If your score if below 8 your home is poorly insulated and you are wasting money on fuel bills.

Activity 3

1. What appears to be happening to the heat in your home?

2. What is an "R" value?

3. How much "R" value is recommended for attics?

4. What is considered the minimum "R" value for walls in Indiana?

5. Why must attics be ventilated?

6. How many inches of fiberglass blanket insulation is needed for a properly insulated attic?

Activity 4

1. Ask your students to devise a way to use a heat lamp and thermometers to test the effectiveness of the wide variety of insulation materials.

APPENDIX I
TERMS

Insulation. Any material that reduces the rate of heat transfer from one place to another. All building materials have some insulation value, but the term "insulation" is generally applied to a group of products designed mainly to provide this reduction of heat transfer.

"R". The "R" value represents thermal resistance to heat flow. This is expressed as a number. The higher "R" value the better the insulation properties.

Vapor Barrier. A vapor barrier is a material which prevents water vapor from entering into the insulation. The condensation of moisture in insulation lowers the insulation's "R" value and is harmful to many building materials.

Attic Ventilation. "Attic ventilation is the term applied to the openings installed in the roof or gables to allow water vapor to escape from the attic and then maintain the insulating qualities of your attic insulation.

APPENDIX II

INSULATION CHART

	R/inch	Inches Required For: R19	R38
Loose Fill Blow -- Machine Fiberglas	2.25	8.5	17
Mineral Wool	3.125	6	12.5
Cellulose	3.7	5.5	10.5
Loose Fill Poured -- Hand Cellulose	3.7	5.5	10.5
Mineral Wool	3.125	6	12.5
Fiberglas	2.25	8.5	17
Vermiculite	2.1	9	18
Batts or Blankets Fiberglas	3.14	6	12.5
Mineral Wool	3.14	6	12.5
Rigid Board Polystyrene Beadboard	3.6	5.5	10.5
Extruded Polystyrene (styrofoam)	4.-5.41	5.-3.5	9.5-7
Urethan	6.2	3	6.5
Fiberglas	4.0	5	9.5
Foam Ureaformaldehyde (UF)	4.8	4	8

Note: An "R" value of R-19 for walls and R-30 for attics is the recommended minimum for Indiana. (R-38 for attics in northern Indiana).

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PLEASE TELL US WHAT YOU THINK ABOUT THE SENIOR HIGH SCHOOL ENERGY MATERIALS

Your position: ______ teacher   Your grade level: ______________
(check) ______ dept. head
______ administrator   Subject(s) taught: ______________
______ other

If possible, please answer these questions after you have taught unit lesson(s) in your class and examined teacher's guide. If this is not possible, please answer based on your personal inspection of the unit materials.

1. What project materials are you evaluating? (Check all that apply).

______ Unit I	______ Unit VI
______ Unit II	______ Unit VII
______ Unit III	______ Unit VIII
______ Unit IV	______ Unit IX
______ Unit V	______ Teacher's Guide

2. What is the basis for this evaluation? (Check all that apply)

______ (1) teaching 4 or more lessons	______ (3) personal inspection
______ (2) teaching 1 to 3 lessons	______ (4) discussion with others who know materials

3. Have you shared these units with other educators? (Check one)

______ (1) No	______ (3) Yes, with 5-10 others
______ (2) Yes, with 1-4 others	______ (4) Yes, with more than 10

Circle the number from 1 (Definitely No) to 7 (Definitely Yes) which best reflects your answer.

	DEFINITELY NO			NEUTRAL			DEFINITELY YES
4. Are these materials easy to understand and use?	1	2	3	4	5	6	7
5. Do these materials fit with the curriculum of your district?	1	2	3	4	5	6	7
6. Are you likely to make use of these materials in the future?	1	2	3	4	5	6	7
7. Are these materials appropriate for the level of your students?	1	2	3	4	5	6	7
8. Are these materials interesting to your students?	1	2	3	4	5	6	7
9. Is the reading level appropriate?	1	2	3	4	5	6	7
10. Do you think these materials will reduce energy consumption?	1	2	3	4	5	6	7

What did you like best? ______________

What did you like least? ______________

Suggestions/Comments (Use the back as needed): ______________

RETURN TO: Energy Education Curriculum Project, Division of Curriculum, Department of Public Instruction, Room 229, State House, Indianapolis, IN 46204.