2013-2014

Energy House

Students learn about efficiency, conservation, and economic returns by using various materials to insulate a cardboard house and then test its efficiency.

$ EFFICIENCY CONSERVATION

Grade Level:

- Int Intermediate
- Ele Elementary

Subject Areas:

- Science
- Social Studies
- Math
- Technology

NEED National Energy Education Development Project

Teacher Advisory Board

NEED Mission Statement

The mission of The NEED Project is to promote an energy conscious and educated society by creating effective networks of students, educators, business, government and community leaders to design and deliver objective, multi-sided energy education programs.

Teacher Advisory Board Statement

In support of NEED, the national Teacher Advisory Board (TAB) is dedicated to developing and promoting standards-based energy curriculum and training.

Permission to Copy

NEED materials may be reproduced for non-commercial educational purposes.

Energy Data Used in NEED Materials

NEED believes in providing the most recently reported energy data available to our teachers and students. Most statistics and data are derived from the U.S. Energy Information Administration's Annual Energy Review that is published yearly. Working in partnership with EIA, NEED includes easy to understand data in our curriculum materials. To do further research, visit the EIA web site at www.eia.gov. EIA's Energy Kids site has great lessons and activities for students at www.eia.gov/kids.

NEED
National Energy Education Development

1.800.875.5029
www.NEED.org

Energy House

Table of Contents

Correlations to National Science Education Standards: Grades K-4

This book has been correlated to National Science Education Content Standards.
For correlations to individual state standards, visit **www.NEED.org**.

Content Standard A | *SCIENCE AS INQUIRY*

- **Abilities Necessary to Do Scientific Inquiry**
  - Ask a question about objects, organisms, and events in the environment.
  - Plan and conduct a simple investigation.
  - Employ simple equipment and tools to gather data and extend the senses.
  - Use data to construct a reasonable explanation.
  - Communicate investigations and explanations.
- **Understandings About Scientific Inquiry**
  - Simple instruments, such as magnifiers, thermometers, and rulers, provide more information than scientists obtain using only their senses.
  - Scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge). Good explanations are based on evidence from investigations.
  - Scientists make the results of their investigations public; they describe the investigations in ways that enable others to repeat the investigations.
  - Scientists review and ask questions about the results of other scientists' work.

Content Standard B | *PHYSICAL SCIENCE*

- **Properties of Objects and Materials**
  - Objects have many observable properties, including size, weight, shape, color, temperature, and the ability to react with other substances. Those properties can be measured using tools, such as rulers, balances, and thermometers.
  - Objects are made of one or more materials, such as paper, wood, and metal. Objects can be described by the properties of the materials from which they are made, and those properties can be used to separate or sort a group of objects or materials.

Content Standard E | *SCIENCE AND TECHNOLOGY*

- **Abilities of Technological Design**
  - Identify a simple problem.
  - Propose a solution.
  - Implementing proposed solutions.
  - Evaluate a product or design.
  - Communicate a problem, design, and solution.

Content Standard F | *SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES*

- **Types of Resources**
  - Some resources are basic materials, such as air, water, and soil; some are produced from basic resources, such as food, fuel, and building materials; and some resources are nonmaterial, such as quiet places, beauty, security, and safety.

Correlations to National Science Education Standards: Grades 5-8

This book has been correlated to National Science Education Content Standards.
For correlations to individual state standards, visit **www.NEED.org**.

Content Standard A | *SCIENCE AS INQUIRY*

- **Abilities Necessary to Do Scientific Inquiry**
  - Identify questions that can be answered through scientific investigations.
  - Design and conduct a scientific investigation.
  - Use appropriate tools and techniques to gather, analyze, and interpret data.
  - Develop descriptions, explanations, predictions, and models using evidence.
  - Think critically and logically to make the relationships between evidence and explanations.
  - Recognize and analyze alternative explanations and predictions.
  - Communicate scientific procedures and explanations.
  - Use mathematics in all aspects of scientific inquiry.
- **Understandings About Scientific Inquiry**
  - Different kinds of questions suggest different kinds of scientific investigations. Some investigations involve observing and describing objects, organisms, or events; some involve collecting specimens; some involve experiments; some involve seeking more information; some involve discovery of new objects and phenomena; and some involve making models.
  - Mathematics is important in all aspects of scientific inquiry.
  - Technology used to gather data enhances accuracy and allows scientists to analyze and quantify results of investigations.

Content Standard B | *PHYSICAL SCIENCE*

- **Transfer of Energy**
  - Energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, nuclei, and the nature of a chemical. Energy is transferred in many ways.
  - Heat moves in predictable ways, flowing from warmer objects to cooler ones, until both reach the same temperature.

Content Standard E | *SCIENCE AND TECHNOLOGY*

- **Abilities of Technological Design**
  - Identify appropriate problems for technological design.
  - Design a solution or product.
  - Implement a proposed design.
  - Evaluate completed technological designs or products.
  - Communicate the process of technological design.
- **Understandings About Science and Technology**
  - Perfectly designed solutions do not exist. All technological solutions have trade-offs, such as safety, cost, efficiency, and appearance. Engineers often build in back-up systems to provide safety. Risk is part of living in a highly technological world. Reducing risk often results in new technology.
  - Technological designs have constraints. Some constraints are unavoidable, for example, properties of materials, or effects of weather and friction; other constraints limit choices in the design, for example, environmental protection, human safety, and aesthetics.

EFFICIENCY CONSERVATION

Teacher Guide

Grade Level

- Grades 4–8

Time

- 1.5-2.5 hours

Materials

- 10 Identical cardboard boxes (approximately 12" x 12" x 12")
- 10 Pieces of heavy transparency film
- 1 Roll of aluminum foil
- 10 Pairs of scissors
- 1 Package of small bead caulking
- 10 Rulers
- 1 Package of small self-stick weatherstripping
- 10 Poster boards
- 1 Roll of bubble wrap
- 10 Plastic zip-lock bags (6" x 6")
- 1 Roll of cotton batting
- Ice cubes
- 1 Roll of padded mailing paper
- Several thermometers
- 10 Rolls of mailing tape
- Meter stick (for center)
- Pencils

Materials can be bought at an office supply outlet and hardware store.

Teacher Tip

Check out NEED's *Building Science* module on our website, www.NEED.org, to explore the science and energy behind keeping buildings comfortable and functional.

Objective

At the close of this lesson, students will be able to describe efficiency and conservation measures for the home, and explain why they make sense economically. Students will purchase and install insulation, caulking, weatherstripping, and windows into a cardboard box house, then test the efficiency of the house.

Concepts

- Heating and cooling a house uses more energy than any other energy task in the house.
- Insulators are materials that do not conduct (or move) heat well.
- Many materials can be used to reduce the energy needed to keep houses at comfortable temperatures.

Preparation

- Familiarize yourself with the Teacher and Student Guides.
- Make one copy of the *Student Guide* and *Cost Sheet* for each student.
- Procure the materials needed and set up a Building Center for the students.
- Make a master or digital projection of page 10 to share with the class.
- Place your students in groups of three.
- Gather play money and divide it up for groups to use. (optional)

Procedure

1. Introduce the activity to the class using the *Insulators and Conductors* page. Discuss the materials in the pictures that are conductors and insulators (see the answer key on page 7 for suggestions). Explain to the class that conductors are materials such as metals that move heat easily; insulators are materials that do not move heat well. Have students discuss what they know about common materials (wood, plastic, glass, metal, leather, water, cement, fabric) and categorize them as conductors or insulators.
2. A good way for students to think more clearly about objects as conductors or insulators is to consider that all the materials in the room are at the same temperature. The students' hands are warmer than the room. Do the objects feel warm or cool when they are touched? Conductors move heat away from the students' hands, making the objects feel cooler. Insulators do not move heat well, so the objects feel warm. Have the students think about stepping from the shower with one foot on a rug and one on a tile floor. Both the rug and the tile are at the same temperature. How do they feel? Which is the conductor and which is the insulator?
3. Distribute the *Student Guides* and *Cost Sheets* to the students and place them into groups. See the next page for examples of extension activities.
4. Review the procedure for the activity with the class, along with any group and safety rules you may have.
5. Show the class the materials in the Building Center.
6. Distribute one box to each group. Make sure students have rulers, scissors, and pencils. Instruct the students to cut out the windows and doors of their houses.
7. Instruct the groups to decide the type and amount of materials they want and write them on the *Cost Sheet*.
8. When the *Cost Sheets* are completed, have a representative from each group go to the Building Center to get the materials. The teacher should act as the Center Manager to distribute materials to the groups.

9. Give groups a specific amount of time (30 minutes to one hour) to insulate the house.
10. When groups are finished, distribute plastic bags filled with ice cubes to each group and have the students close their houses with the bags of ice on the floor of the house.
11. Have the students measure the temperature of the classroom and record it on their *Cost Sheets*.
12. After ten minutes, have each group measure the temperature inside of their houses by carefully sliding a thermometer above the door, and recording the measurement on the *Cost Sheets*.
13. Explain the formula for calculating energy savings on the *Cost Sheet* and have each group calculate their savings. *Note: $3.00/°C/ year is an estimated savings for each degree.*
14. Discuss the energy savings that insulation can produce, especially in the context of cost—the more insulation you use, the more energy savings. At some point, however, the increase in cost is not economically feasible when you compare the amount of energy saved, or you reduce the amount of usable space too much. Materials that are really good insulators usually cost more than less-efficient insulators, so you need to consider the trade-offs and balance the energy saved with the cost.
15. Discuss other materials groups could have used as insulation, such as foam board. Discuss what groups would change if they could do the activity again with additional materials.
16. Evaluate the activity with the class using the *Evaluation Form* on page 11.

Extension Activities

1. Have students draw blueprints of their houses to scale and devise written plans to insulate their houses before they begin the activity.
2. Have students devise an experiment to determine the insulating qualities of the insulating materials before insulating the houses. One simple experiment is to insulate cold drink cans with various materials to see which material keeps the liquid the coldest.
3. Have students devise an experiment to explore the insulating qualities of materials with which houses are made, such as wood, brick, stucco, block, etc.
4. Have a building contractor visit the class to discuss energy-saving materials and techniques in the building industry.
5. Have students survey their own homes to determine how well their homes are insulated and what measures could be undertaken to make their homes more energy-efficient. See *Energy Conservation Contract,* available for free download at www.NEED.org, to teach students how to save energy at home with their families.
6. Have students survey the school to determine how well the building is insulated and what measures could be undertaken to make the school more energy-efficient. See *Monitoring and Mentoring,* available for free download at www.NEED.org, to teach students how to survey buildings and learn about conservation and efficiency measures at school.

Answer Key For Insulators and Conductors Master

- **Metal Pan with Plastic Handle:** Metal is a conductor—it conducts heat to the food inside to cook it efficiently. Plastic is an insulator—it does not conduct heat from the pan to a person's hands.
- **Metal Kettle with Wooden Handle:** Metal is a conductor—it conducts heat to the water inside to warm it efficiently. Wood is an insulator—it does not conduct heat from the kettle to a person's hands.
- **Metal Spoon with Plastic Handle:** Metal is a conductor—it conducts heat. Plastic is an insulator—it does not conduct heat from the spoon to a person's hands.
- **Fabric Oven Mitt:** Fabric is an insulator—it does not conduct heat from hot pans to a person's hands. Discuss blankets and clothes as insulators. What would happen if the fabric mitt got wet? Is water a conductor or insulator? (conductor)
- **Thermos (Vacuum) Bottle:** There is a space between the inside liner and the outside material of a vacuum bottle in which most of the air has been removed. Since heat travels from molecule to molecule, a space with few molecules is a good insulator. Double pane windows work on the same principle.
- **Ceramic or Plastic Cup:** Ask the students whether the cup would be hotter if made of ceramic or plastic (ceramic). Which is the better insulator? (plastic)

Student Guide

✪ Challenge

You have been chosen to build a house that must meet the local building code, and efficiently insulate the home in order to save the homeowners energy costs for years to come.

Question

What materials will most efficiently insulate your Energy House?

☑ Procedure

1. Draw two windows (10 cm x 10 cm) and one door (10 cm x 20 cm) on your house.
2. Carefully cut out the windows and the door, leaving one side of the door attached.
3. Examine your house to determine its insulation needs. Read the Building Code below.
4. Examine the materials available and their cost. As a group, decide which materials you want to use and the amount. Write them on your *Cost Sheet*.
5. Purchase the materials and insulate your house, following the Building Code. You can purchase additional materials if you need them. Make sure to add them to your *Cost Sheet*.
6. When your house is finished, fill a plastic bag with eight ice cubes, place it flat on the floor of the house and close the house.
7. Measure and record the temperature of the classroom.
8. After ten minutes, record the temperature of your house at ceiling level by carefully sliding the thermometer into the house through the top of the door, taking care not to allow cool air to escape.
9. Calculate your energy savings on your *Cost Sheet*.

Building Code

- The door must open and close. If you add a storm door, it must open.
- Windows do not have to open but you must be able to see through them.
- The ceiling must be at least 5 cm above the top of the door.
- Insulation on the floor and walls cannot exceed 1 cm in thickness.
- No insulation can be exposed. All insulation must be covered by a ceiling, wall, or floor (poster board).

⁂ Conclusion

1. Analyze your home design, the insulating materials you used, and energy savings. How efficient was your home at maintaining its temperature? How did your cost for materials compare to the money saved in the long term? What would you do differently if you could design your house again?
2. Compare your results with other groups.

Cost Sheet

AMOUNT				TOTAL COST
________	Mailing Tape	@	$0.50 roll	____________
________	Plastic Film	@	$0.25 each	____________
________	Aluminum Foil	@	$0.20/meter	____________
________	Poster Board	@	$0.50 each	____________
________	Bubble Wrap	@	$1.00/meter	____________
________	Cotton Batting	@	$0.75/meter	____________
________	Padded Paper	@	$0.50/meter	____________
________	Caulking	@	$0.01/cm	____________
________	Weatherstripping	@	$0.01/cm	____________
		Total Cost for Materials:		____________

1. Room temperature (°C): __________

2. House temperature (°C): __________

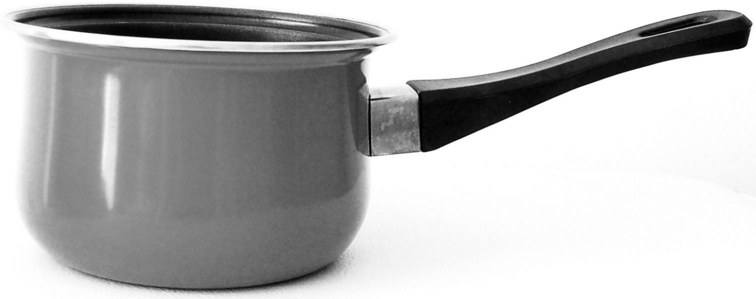
3. Difference (Δ) in temperature (°C): __________

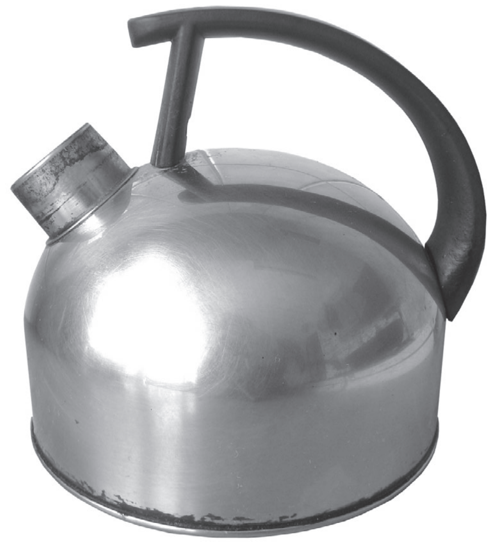
Total savings = [Δ °C x ($3.00/°C/year x 10 years)] – total cost for materials

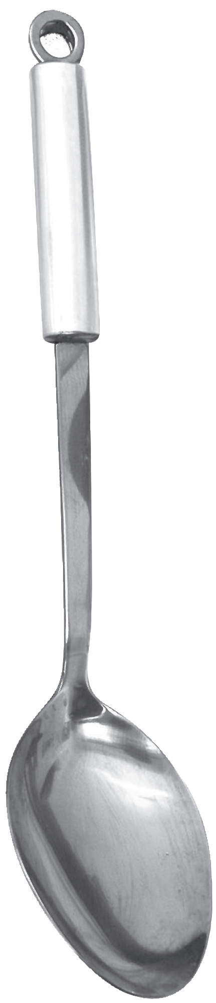
4. Total savings: ________________

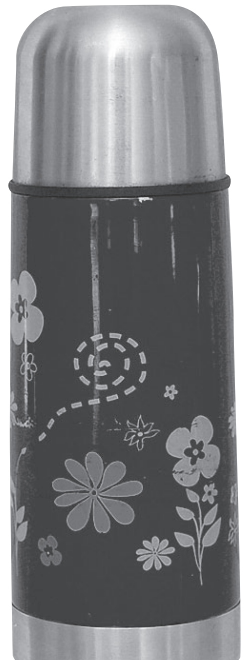
5. If I did the activity again, I would change____________ about my house:

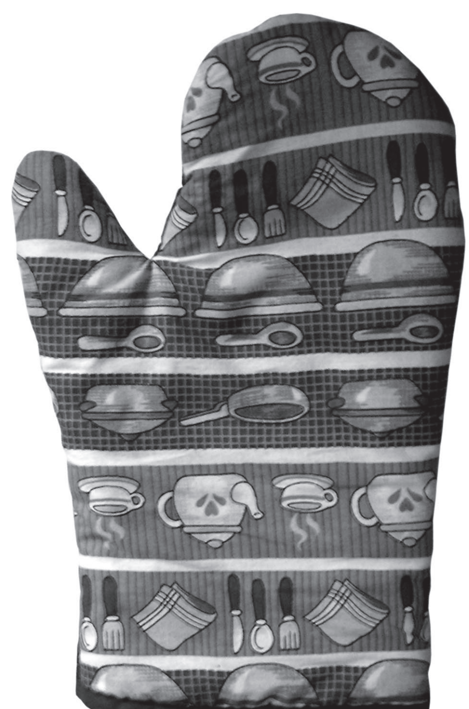
Insulators and Conductors











Energy House Evaluation Form

EFFICIENCY CONSERVATION

State: ____________ **Grade Level:** ____________ **Number of Students:** ___________

1. Did you conduct the entire activity?	❑ Yes	❑ No
2. Were the instructions clear and easy to follow?	❑ Yes	❑ No
3. Did the activity meet your academic objectives?	❑ Yes	❑ No
4. Was the activity age appropriate?	❑ Yes	❑ No
5. Was the allotted times sufficient to conduct the activity?	❑ Yes	❑ No
6. Was the activity easy to use?	❑ Yes	❑ No
7. Was the preparation required acceptable for the activity?	❑ Yes	❑ No
8. Were the students interested and motivated?	❑ Yes	❑ No
9. Was the energy knowledge content age appropriate?	❑ Yes	❑ No
10. Would you use this activity again?	❑ Yes	❑ No

Please explain any 'no' statement below.

How would you rate the activity overall?	❑ excellent	❑ good	❑ fair	❑ poor
How would your students rate the activity overall?	❑ excellent	❑ good	❑ fair	❑ poor

What would make the activity more useful to you?

Other Comments:

Please fax or mail to: **The NEED Project**
P.O. Box 10101
Manassas, VA 20108
FAX: 1-800-847-1820

National Sponsors and Partners

American Electric Power
American Wind Energy Association
Appalachian Regional Commission
Arizona Public Service
Arizona Science Center
Arkansas Energy Office
Armstrong Energy Corporation
Association of Desk & Derrick Clubs
Audubon Society of Western Pennsylvania
Barnstable County, Massachusetts
Robert L. Bayless, Producer, LLC
BP
BP Alaska
Blue Grass Energy
Brady Trane
Cape Light Compact–Massachusetts
L.J. and Wilma Carr
Center for Teacher Success
Chabot Space and Science Center
Chevron
Chevron Energy Solutions
Columbia Gas of Massachusetts
ComEd
ConEdison Solutions
ConocoPhillips
Constellation
Daniel Math and Science Center
David Petroleum Corporation
Denver Public Schools
DePaul University
Desk and Derrick of Roswell, NM
Dominion
DonorsChoose.org
Duke Energy
East Kentucky Power
Eastern Kentucky University
El Paso Corporation
E.M.G. Oil Properties
Encana
Encana Cares Foundation
Energy Education for Michigan
Energy Training Solutions
First Roswell Company
FJ Management. Inc.
Foundation for Environmental Education
FPL
The Franklin Institute
Frontier Associates
Georgia Environmental Facilities Authority
Georgia Power
Government of Thailand–Energy Ministry
Green Power EMC
Guam Energy Office
Guilford County Schools – North Carolina
Gulf Power
Harvard Petroleum
Hawaii Energy
Gerald Harrington, Geologist
Houston Museum of Natural Science
HoustonWorks
Hydro Research Foundation
Illinois Clean Energy Community Foundation
Independent Petroleum Association of America
Independent Petroleum Association of New Mexico
Indiana Michigan Power
Interstate Renewable Energy Council
Kentucky Clean Fuels Coalition
Kentucky Department of Education
Kentucky Department of Energy Development and Independence
Kentucky Power – An AEP Company
Kentucky River Properties LLC
Kentucky Utilities Company
Linn County Rural Electric Cooperative
Llano Land and Exploration
Louisiana State University Cooperative Extension
Louisville Gas and Electric Company
Maine Energy Education Project
Maine Public Service Company
Marianas Islands Energy Office
Massachusetts Division of Energy Resources
Michigan Oil and Gas Producers Education Foundation
Miller Energy
Mississippi Development Authority–Energy Division
Montana Energy Education Council
NADA Scientific
NASA
National Association of State Energy Officials
National Fuel
National Grid
National Hydropower Association
National Ocean Industries Association
National Renewable Energy Laboratory
Nebraska Public Power District
New Mexico Oil Corporation
New Mexico Landman's Association
NRG Energy, Inc.
NSTAR
OCI Enterprises
Offshore Energy Center
Offshore Technology Conference
Ohio Energy Project
Pacific Gas and Electric Company
Paxton Resources
PECO
Pecos Valley Energy Committee
Petroleum Equipment Suppliers Association
Phillips 66
PNM
Read & Stevens, Inc.
Rhode Island Office of Energy Resources
RiverWorks Discovery
Robert Armstrong
Roswell Geological Society
Sandia National Laboratory
Saudi Aramco
Schneider Electric
Science Museum of Virginia
C.T. Seaver Trust
Shell
Shell Chemicals
Snohomish County Public Utility District–WA
Society of Petroleum Engineers
David Sorenson
Southern Company
Southern LNG
Southwest Gas
Space Sciences University–Laboratory of the University of California Berkeley
Tennessee Department of Economic and Community Development–Energy Division
Tioga Energy
Toyota
Tri-State Generation and Transmission
TXU Energy
United Parcel Service
United States Energy Association
United Way of Greater Philadelphia
University of Nevada–Las Vegas, NV
University of Tennessee
University of Texas - Austin
University of Texas - Tyler
U.S. Department of Energy
U.S. Department of Energy–Hydrogen Program
U.S. Department of Energy–Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy–Office of Fossil Energy
U.S. Department of Energy–Wind for Schools
U.S. Department of Energy–Wind Powering America
U.S. Department of the Interior–Bureau of Land Management
U.S. Energy Information Administration
Van Ness Feldman
Vestas
Virgin Islands Energy Office
West Bay Exploration
W. Plack Carr Company
Yates Petroleum Corporation