ENERGY OFFICE

LESSON PLAN

Get Current on Energy

Grade 4, 6 & 7

SUMMARY

This lesson encourages students to get data from different sources (e.g., observations, informational texts, charts, graphs, videos) to identify and describe problems related to the transfer of heat energy both in terms of facilitating (helping) and/or inhibiting (blocking) heat transfer.

LESSON OBJECTIVES

Upon completing this lesson the students will:

- Understand energy forms and sources;
- Distinguish between conductors and insulators of heat transfer;
- Recognize and compare insulation values of various materials as energy savers; and
- Learn ways to conserve energy at school and at home.

ESSENTIAL QUESTIONS

1. What is the difference between conductors and insulators?
2. What are ways to conserve energy at school and home?

DURATION

The activity requires two to three class periods.

COLLEGE & CAREER-READY SCIENCE STANDARDS 2021

GRADE 4

STANDARD

4-ESS3-1 Obtain and combine information to describe that energy and fuels are derived from natural resources and how their uses affect the environment.

DISCIPLINARY CORE IDEA (DCI)

ESS3.A: Natural Resources

All materials, energy, and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. Some resources are renewable over time, and others are not.

CROSS-CUTTING CONCEPTS (CCC)

Cause and Effect:

Relationships are routinely identified and used to explain change.

GRADE 6

STANDARD

6-PS3-3 Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.

DISCIPLINARY CORE IDEA (DCI)

PS3.A: Definitions of Energy The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and energy transfers by convection, conduction, and radiation (particularly infrared and light).

PS3.B: Conservation of Energy and Energy Transfer

The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment. Energy is spontaneously transferred out of hotter regions or objects and into colder ones by the processes of conduction, convection, and radiation.

CROSS-CUTTING CONCEPTS (CCC)

Energy and Matter:

The transfer of energy can be tracked as energy flows through a designed or natural system.

GRADE 7

STANDARD

7-PS1-3 Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

DISCIPLINARY CORE IDEA (DCI)

PS1.A: Structure and Properties of Matter

Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.

CROSS-CUTTING CONCEPTS (CCC)

Structure and Function:

Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.

MATERIALS

EXPERIMENT 1

- Student Handouts and Activity Sheets (provided at the end of this lesson)
- Several Thermometers (for taking temperature measurements in the classroom)
- Ice Cubes (one for each student)
- Paper Cups (one for each student)
- Insulation Material (enough to wrap individual paper cups – assign students to bring these)

EXPERIMENT 2

- Large Glass Bowl
- Small Glass Bowl
- 3 Spoons (plastic, metal, wood)
- 3 Beads
- Butter
- Boiling Water
- Timer
- Thermometer (optional)

ESSENTIAL LEARNING

BACKGROUND INFORMATION

This lesson encourages students to obtain information from different sources, including observations, informational texts, videos and more to identify and describe problems related to the transfer of heat energy, both in terms of facilitating/helping heat transfer and/or inhibiting/blocking heat transfer. For example:

- A student's hot cocoa gets cold quickly when served in a paper cup;
- Students are burned while sliding down the metal slide at recess; and
- Classroom laptops are overheating and turning off during use by students.

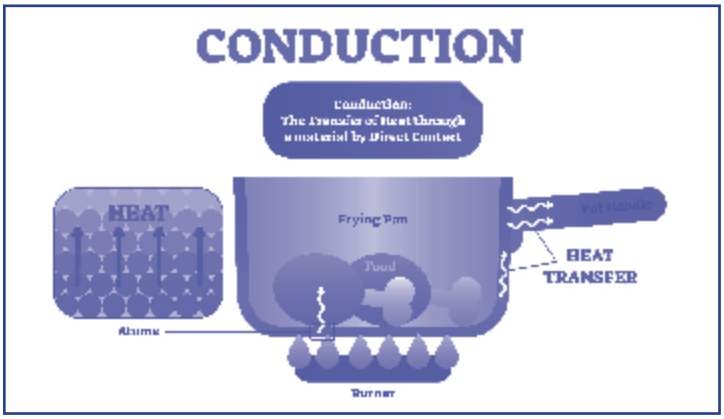
The students should engage in the design process to create and test different solutions to solve the problem of heat transfer through insulating or conducting the transfer of thermal energy. This process should include asking questions about problems related to using insulators to inhibit heat transfer or using conductors to facilitate heat transfer.

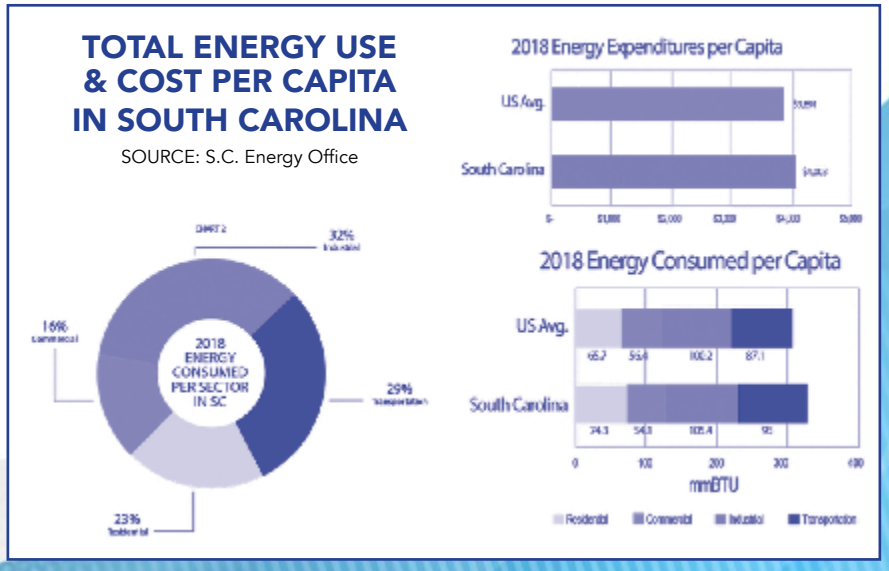
According to the U.S. Energy Information Administration, for residential, commercial, industrial and transportation energy combined, the average American spent $3,495 per person in 2017, while the average South Carolinian spent $3,776 (Chart 1). The industrial sector accounted for 33 percent of the total energy consumption (to include all fuel sources) and transportation accounted for 29 percent (Chart 2). S.C. residents consumed 327 million BTUs per person in 2017, compared to an average of 300 million in the United States (Chart 3).

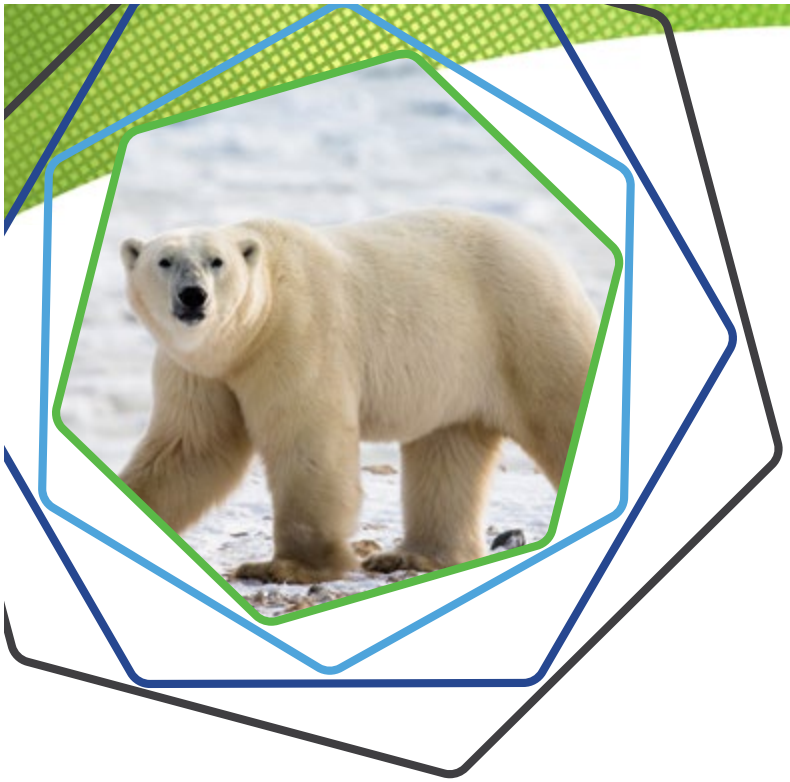
Applying an understanding of heat transfer, insulators and conductors, design a solution or device that include the following:

- **Conductors** of heat transfer facilitate or help the transfer of heat energy. Material that allows heat to move easily through them, and from one object to another through direct contact, are called conductors. Metal objects are good conductors of heat because heat can transfer easily through the metal. For example, the handle of a metal spoon will become warm when the spoon is placed in hot water; and
- **Insulators** of heat transfer inhibit or block the transfer of heat energy. Material that does not allow heat to move easily through them or from one object to another through direct contact are called insulators. Wooden and plastic objects are good insulators of heat because heat does not transfer easily through them. For example, the handle of a wooden or plastic spoon does not become warm when the spoon is placed in hot water.

Testing their devices or solutions and collecting data is important to see how effective their solutions are at insulating or conducting heat transfer. They can analyze







and interpret their data to determine if their solutions are successful in facilitating or inhibiting heat transfer. They also can use their data to refine and retest their designs (if necessary) and discuss their solutions.

The students should be encouraged to develop and use models to describe and compare how heat energy can transfer in the three ways (i.e., conduction, convection, radiation). Conduction is the transfer of thermal energy through direct contact. The transfer of energy as heat occurs between particles as they collide within a substance or between two objects in contact. All materials do not conduct heat energy equally. Poor conductors of heat are called insulators. For example, if a plastic spoon and a metal spoon are placed into a hot liquid, the handle of the metal spoon will get hot quicker than the handle of the plastic spoon because the heat is conducted through the metal spoon better than through the plastic spoon. The energy transfers from an area of higher temperature to an area of lower temperature.

By designing and testing devices, you can determine how various materials and/or combinations of materials affect how quickly heat transfers by conduction, convection or radiation

- **Conductors** are materials that easily carry heat or electric current. Glass and metals are good conductors of heat. When a metal pan is placed on a heat source, it will quickly get hot and conduct the heat to whatever is inside of the pot.
- **Insulators** are materials that are poor carriers of heat or electric current. Wood and animal fat (blubber) are good insulators; they do not conduct heat very well. A polar bear swims in freezing water but the bear does not freeze to death as a human would. The bear's thick layer of fat insulates the bear and traps heat inside of the bear's body. Various materials – including but not limited to, water, metal, glass, wood, plastic, air and reflective and non-reflective substances – should be tested in order to determine how well each conducts heat by conduction, convection and/or radiation.

ENGAGE

Begin the lesson by getting the student's attention about energy by showing the video ***How to Save Energy for School Teaching*** at **https://youtu.be/_WAWFEr9p30**.

EXPLORE

SOURCES

This lesson was taken in part from ***The Support Guide 3.0 for Third- and Sixth-Grade South Carolina Academic Standards and Performance Indicators for Science***.

Additional material was provided the S.C. Department of Health and Environmental Control's ***Action for a Cleaner Tomorrow: An Environmental Curriculum Supplement***.

DID YOU KNOW?

A **Btu** is the amount of heat required to raise the temperature of one pound of water by one degree Fahrenheit.

1. As a class, have the students prepare a list of the 10 most needed uses of electricity at home. NOTE: These may include the stove, refrigerator, lights, heating, air conditioning, hot water heater, microwave, TV, alarm clock, washing machine, clothes dryer, hair dryer, computer, etc.
2. Discuss what life would be like without these 10 most needed uses of electricity. Are these items necessities or luxuries? Have the class make determinations based on their opinions. There are no right or wrong answers.
3. Have the class list other uses of electricity outside their home that are necessities. These may include traffic lights, hospital equipment, etc.
4. Discuss with the class that there is an alternative at home to just not using electricity and that the alternative is conserving electricity by using energy-efficient appliances and by using them wisely. Additionally, you can avoid using electricity by doing things such as hanging clothes to dry and opening windows instead of running the air conditioner.
5. Ask, ***"What are some examples of wasting electricity?"*** Review your top 10 list and how electricity can be wasted by improper use. For example, running the heat with windows open, leaving lights on when no one is home, leaving televisions on when you're not watching and leaving the refrigerator door open.

EXPLAIN

Have the students investigate ways to conserve energy at school.

1. Try to locate the areas of your classroom with the greatest heat/energy loss (during the heating season or the area of greatest cooling loss in the summer). Ask the students to predict where these areas might be. Write their predictions on the board.
2. Place several thermometers around the classroom (e.g., by doors and windows, high in the class and low to the floor, next to an inside wall – but avoid putting a thermometer next to the heating/cooling register). Assign a team of students to take readings at various times during the day. (Every hour works well.)
3. Record their findings on the board by location and determine the following:
   - ***Where is the room warmest?***
   - ***What is the coldest location?***
   - ***Where do you think heat is moving out of the room?***
   - ***What are your ideas for keeping heat in the room?***
4. Discuss how insulation helps keep heat in the classroom. Insulation is any material that prevents the movement of heat.
5. Show the students the video ***What's the Best Insulator?*** at **https://youtu.be/l81M7Xhwzk0**.

ELABORATE

Distribute copies of ***My Home Energy Conservation Checklist*** and discuss it with the class.

- ***What do the students think about these conservation methods?***
- ***Which ones are the students already doing?***
- ***Which ones do they think make a difference?***
- ***Which ones do they think are too much trouble or too inconvenient?***

Ask the students to select several of these conservation methods to discuss with their families. Use the ***My Home Energy Conservation Proposal*** form included with this lesson and have students fill out suggestions for their families. Encourage the students to take the list home.

EVALUATE

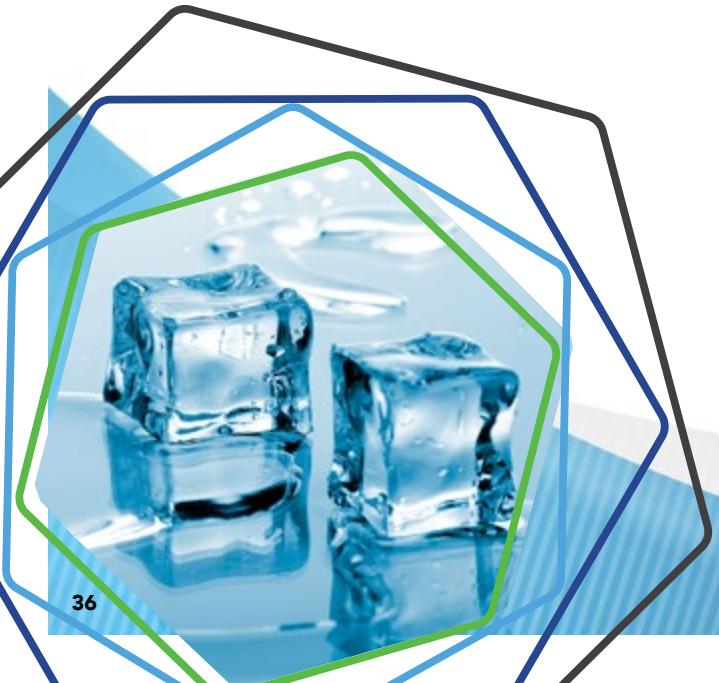
DID YOU KNOW?

Some metals that are GOOD CONDUCTORS of heat include **brass**, **copper**, **iron**, **lead** and **silver**.

Some materials that are GOOD INSULATORS of heat include **fiberglass**, **mineral wool**, **cellulose**, **natural fibers**, **polystyrene** and **polyurethane**.

EXPERIMENT 1

1. Tell the students that they are going to conduct an experiment in class testing different types of material for their insulation quality. Assign the students to bring in a piece of insulation material that they think will help to keep an ice cube from melting. This could be a scrap of cloth, plastic, paper, etc. Ask the students not to bring Thermos™ or Yeti bottles or coolers.
2. For the experiment, give each student a copy of the ***Melt Down Student Worksheet*** to review.
   a. Quickly give each student an ice cube in a paper cup and instruct students to wrap the cup and cube in their material quickly.
   b. Have all students place their experiment cups in the same location. Remind them that the temperature in the room can vary and that this variation would effect the experiment results.
   c. You will need to call out the start and check times so that all students are working on the same time line.
   d. Allow the students to check their experiments and record results on their student sheets.
   e. During the experiment, as students say their cube has melted, record on the board the type of insulation material and the time.
3. Ask the class, ***"Which ice cube lasted longest? What was the most effective insulation? What is the purpose of insulation?"***



EXPERIMENT 2

In this activity, the students will discover how various materials conduct heat differently. Begin the experiment following these steps:

1. Place the three spoons (plastic, metal, wood) in a shallow glass dish with the handles at the bottom and the mouth of each spoon extending over the rim. Place the smaller glass dish on top of the spoon handles.
2. Put a small pat of butter in the mouth of each spoon.
3. Put a bead on each pat of butter.
4. Carefully pour hot boiling water into the smaller dish and let it overflow into the larger dish until it is almost completely full.
5. Set the timer and observe what happens to the butter and beads.

Watch the experiment for 5-10 minutes to see what happens. Conclude the experiment by asking these questions:

BEFORE THE EXPERIMENT: HYPOTHESIS

- ***Which bead fell off first? Why?***

AFTER THE EXPERIMENT

- ***Which spoon's butter is melting fastest? Why?***
- ***How long did it take each spoon's butter to melt?***
- ***Which material conducts heat best – wood, plastic or metal?***

The results should show that metal is a good conductor of heat, while wood and plastic are good insulators.

E-LEARNING ACTIVITY

HEAT TRANSFER VIRTUAL LAB

Learn about heat transfer and how to keep things warm by testing the characteristics of different materials with this fun activity for kids. Some materials are good thermal conductors, easily letting heat pass through them, while others are good thermal insulators, not easily letting heat pass through them.

Conduct experiments and watch how the temperature changes. Record your results on a table and make your own conclusions, some materials help keep things warm while others make them get cold quickly. Find out if metal, cardboard, and polystyrene are good at thermal insulation or have good thermal conductivity by checking out this heat transfer activity.

Visit **www.sciencekids.co.nz/gamesactivities/keepingwarm.html** for more details.

STUDENT WORKSHEET NAME: _____

MELT DOWN

This experiment can give you a clue about how energy used for heating and cooling your home and school can be conserved.

1. Place the ice cube in the paper cup and wrap your insulation material around the cup. Wrap tightly so that the cup can still sit upright on your desk. Do not handle your cup too much. (Remember your hands are warm!)
2. Record on the chart below the time the experiment began. Your teacher will call this time for you.
3. Place your insulated cup in the area your teacher has set aside. (Remember temperatures vary around the class. It is important that all the cups are placed in the same location.)
4. Periodically check your cup to see how much of the ice has melted.
5. Record the progress of your ice cube. Record these stages:
   - **Started melting**;
   - **Melting some**;
   - **Mostly melted**; and
   - **Melted**.
6. Subtract the time your ice cube melted from the time the experiment began to find out how long it took your ice cube to melt.

Melt Down Record

START TIME	10 MINUTES	15 MINUTES	20 MINUTES	FINISH TIME

My ice cube was wrapped in _____. My ice cube melted in _____ minutes.

STUDENT WORKSHEET NAME: _____

INSULATION PERCENTAGES

HEATING & COOLING CONSERVATION

- ❑ Adjusting your thermostat is the best and least costly conservation measure. Try to get used to lower temperatures in winter and warmer temperatures in summer. See if your family will agree to set the temperature at 68 degrees or lower for winter heating savings, and 78 degrees or higher for summer cooling savings. You will save 5-6 percent on the utility bill.
- ❑ Locate the thermostat on an inside wall that's not near sunlight, vents or lamps. This way you'll get an accurate reading of the temperature.
- ❑ Dress appropriately. Keeping comfortable has a lot to do with how well you insulate or ventilate your own body. Try loose-fitting clothing, open collars and open weaves for hot weather, layers of clothes and closed collars for colder weather.
- ❑ In cold weather, use more blankets or a down comforter.
- ❑ In the winter months, leave shades, blinds and curtains open on sunny days so you can make use of the sun's heat. Close them on cloudy days to prevent heat loss. Reverse the process in the summer.
- ❑ Close the fireplace damper when it's not in use to prevent heat loss.
- ❑ Don't cover the top of heating or cooling vents with knick-knacks, bowls or belongings. This makes it necessary to use more energy. Also, don't hide vents behind draperies for the same reason.
- ❑ Help cool weather come into your home in the summer. The more cool air you let in, particularly at night, the better.
- ❑ Experiment to see which windows and doors to open or close to create the best flow of cool air through your home.
- ❑ Let hot air out. Encourage your parents to open the upper vents in your attic and make sure any lower vents are not blocked.
- ❑ Since hot air rises, open the upper part of double-hung sash windows and – in a two-story house – the upstairs windows.
- ❑ Let breezes into your home. If windows are blocked by shrubs or tree foliage, the bushes might need pruning.
- ❑ An exhaust fan in a window can push out warm air and pull in cool air. A window fan is more economical to run than an air conditioner. A window fan in an apartment or one-story house should be in a window on the warmest side; in a two-story house, put it in an upstairs window.
- ❑ Use ceiling fans if you have them. In the winter run them counterclockwise to force hot air downward. In the summer, run them clockwise to circulate cooled air. Only use them if a person is in the room.
- ❑ If you have central air conditioning, don't close off unused rooms or shut off vents. Rather than saving energy, this makes the system work harder.
- ❑ It may be easier to move yourself into a warm sunny room on a cold day, say to do homework or eat a snack, than it is to move that free solar heat to a cooler part of your home. And upholstered furniture, like a big armchair or sofa, will soak up the heat very nicely when placed in a sunny spot.
- ❑ Encourage your family to use storm doors and windows. Make sure the storm windows are fastened tightly and the doors are closed properly.
- ❑ When it's time to paint the outside of your home, suggest using light colors. Since South Carolina's climate tends to be warm, light-colored paint is a good choice because it reflects sunlight.

WATER HEATING CONSERVATION

- ❑ Use hot water wisely. Don't let water run while you go in the other room. Don't use hot water if cold or lukewarm will do. For example, run the garbage disposal with cool water, not warm.
- ❑ Try to get in the habit of taking a shower instead of a bath. Showers typically use less hot water. Water-saving shower heads will typically pay for themselves in a few months.

Continued on back

- ❑ Be on the alert for leaky faucets. A two-cent washer can save hundreds of gallons of water over the course of a year.
- ❑ Wash clothes in cold water when possible.

APPLIANCE CONSERVATION

- ❑ Cut back on the amount of water you use for boiling eggs, potatoes and other foods. The more water you use, the more energy is needed to make it boil or simmer.
- ❑ Use pots that are the same size as a burner, so that heat doesn't escape.
- ❑ Make sure pot and pan lids fit tightly. This keeps heat inside. It also makes the food cook faster.
- ❑ If you have a toaster oven or electric frying pan, use it. They use half the electricity of an electric oven.
- ❑ Every time you use a microwave, you save energy. Microwaves not only cook food in one fourth the time, they save 30-70 percent electricity.
- ❑ Avoid peeking in the oven. It not only makes a soufflé fall, it drops the oven's temperature 25-50°F every time it's opened.
- ❑ Periodically vacuum the condenser coils on the back or bottom of your refrigerator. (Unplug it first!) Dust acts as an insulator on the cables, making the refrigerator work harder.
- ❑ Refrigerators and freezers work best when they are full. Items, however, need to have space between them so that air can circulate.
- ❑ Don't place hot or uncovered foods in the refrigerator. It takes increased energy to cool hot foods. Uncovered foods will lose moisture to the refrigerator.
- ❑ Test to make sure the refrigerator and freezer seals are working by placing a dollar bill lengthwise along the edge and closing the door. If the dollar falls, your appliance needs to have the seal replaced. An airtight seal helps the appliance work efficiently.
- ❑ Utility companies suggest that you put petroleum jelly along refrigerator and freezer seals to make them last longer.
- ❑ Defrosting frozen foods in the refrigerator helps the refrigerator stay cool. It also uses less energy than microwave defrosting and, in the case of Thanksgiving turkey, is safer than defrosting on a counter top where bacteria might grow.
- ❑ A freezer with more than 1/4 inch of ice needs to be defrosted to save energy.
- ❑ Always wait until you have a full load to run the dishwasher, washer or dryer. Full doesn't mean overloaded. Overloading wastes energy and rarely gets the job done. On a sunny day, think about using the solar dryer – the clothes line.
- ❑ Turn off the TV, radio, computer or video game when they're not in use.
- ❑ If you have an "instant on" TV, part of the TV is actually on all the time. One way to really turn this type of TV off is to plug it into a socket that is controlled by a light switch and to use that light switch when you turn off the set.
- ❑ Encourage your family to pay attention to the yellow energy tags and labels when buying new appliances. Comparing tags is an excellent way to help your family make an energy-wise choice. The higher the efficiency level, the greater the savings as you use the appliance.

LIGHTING CONSERVATION

- ❑ Use lower watt bulbs in stairwells, closets and areas that don't require reading light.
- ❑ Wherever possible, use LED bulbs. These give as much light as conventional bulbs but use significantly less energy. For example, the light output from a 16 Watt LED light is the same as an incandescent 100 Watt bulb.
- ❑ Use energy-saver bulbs. These give as much light as conventional bulbs but use less energy.
- ❑ Encourage your family to use LED bulbs. These bulbs are comparatively expensive to buy, but are long-lasting and extremely economical over the long run.
- ❑ Suggest using light-colored lamp shades. They reflect 50 percent more light than dark shades.
- ❑ Try placing a lamp in a corner of a room. Here, it has two surfaces to reflect off of rather than just one wall.

STUDENT WORKSHEET NAME: _____

MY HOME ENERGY CONSERVATION PROPOSAL

I suggest that my family look at these ways to save energy. I'm willing to do my part to see that these energy-savings ideas are practiced by my family.

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

10. _____

11. _____

12. _____