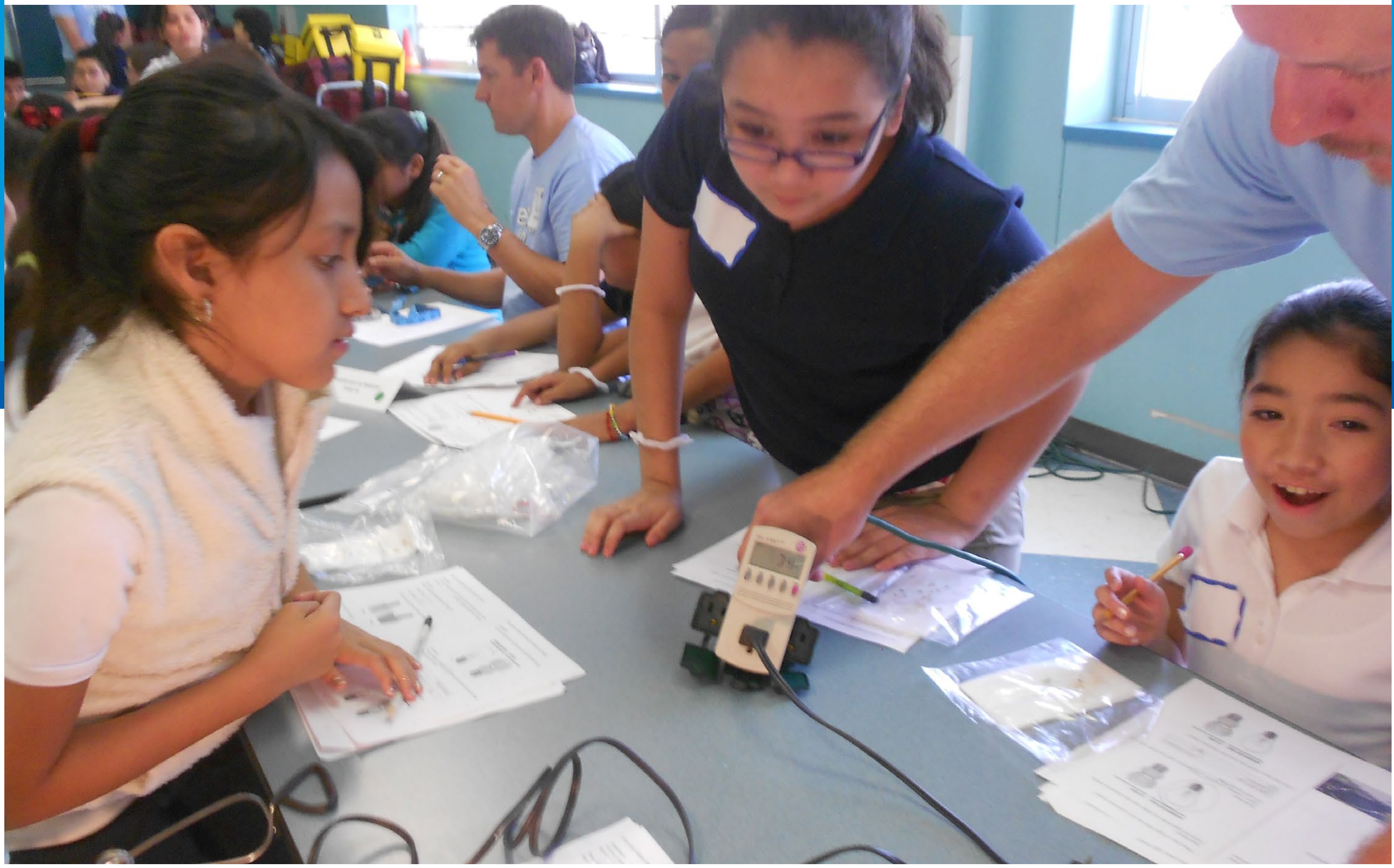
SAVING ENERGY AT HOME

TEACHER GUIDE

2016-2017



ENERGY EFFICIENCY EDUCATION

OHIO energy PROJECT

ENERGY EFFICIENCY EDUCATION

Welcome to Ohio Energy Project's (OEP) Energy Efficiency Program - providing teachers with the knowledge, curriculum, and hands-on laboratory equipment to help students understand effective use of power sources.

Through an innovative "school to home" approach, students receive free Home Energy Efficiency Kits to educate their families. By installing efficiency measures students are leading the next generation of wise energy consumers and saving money on their family's utility bill. In addition, students receive a Student and Family guide, an excellent resource to use at school and at home. After installing efficiency measures, students complete an online installation survey.

Energy efficiency education partners provide this program to schools, educators and families in their service territory. Partners are:

- AEP Ohio
- Columbia Gas of Ohio
- Dayton Power & Light
- Ohio's Electric Cooperatives
- Vectren

Energy Data Used in Materials

Most statistics and data contained within these materials are derived from the U.S. Energy Information Administration. Data is collected and updated annually where available. Where annual updates are not available, the most current, complete data year is accessed. For access to data, visit www.eia.gov.

Ohio's Learning Standards

All curriculum is aligned to Ohio's Learning Standards. These standards reflect what all students should know and be able to do to become scientifically literate citizens. These standards equip students with knowledge and skills for the 21st century workforce and higher education.

History of OEP's Energy Efficiency Program

Since 2009, Ohio's electric and gas utilities have partnered with OEP to deliver exceptional educational programs for Ohio's educators and provide home energy efficiency kits to families. The installation of these measures have been claimed as savings to the Public Utilities Commission of Ohio as part of the utilities' residential efficiency plans.

The Ohio Energy Project (OEP) is a nonprofit organization dedicated to working with Ohio teachers on energy education. We facilitate students' and teachers' understanding of the science of energy and its efficient use in order to empower the next generation of energy consumers. Our no cost programs are funded through grants and partnerships with business, utilities, governments and foundations.

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.

SAVING ENERGY AT HOME

TEACHER GUIDE

Table of Contents

All students receive the materials listed in the "Basic Student Kit." Some sponsors include additional materials listed below.

BASIC STUDENT KIT

- CFL Light Bulb
- Flow Meter Bag
- Hot Water Temperature Gauge
- Refrigerator/Freezer Thermometer
- Weather Stripping

AEP OH/COH

- Aerator Bath/Kitchen
- LED bulb (2)
- Nightlight
- Plumbers Tape
- Scratch and Sniff
- Showerhead

COH Only

- Aerator Bath/Kitchen
- Plumbers Tape
- Scratch and Sniff
- Showerhead

DPL/Vectren

- Aerator Bath (2)/Kitchen
- Air Temperature Cost Calculator
- Door Sweep
- LED bulb (2)
- Nightlight
- Plumbers Tape
- Scratch and Sniff
- Showerhead

Ohio Electric Cooperatives

- Air Temperature Cost Calculator
- Door Sweep
- Draft Stoppers

CLASSROOM KIT

NEW Teacher

- Carpet Square Sample
- Coal Sequence Activity
- Digital Thermometers
- Energy Efficiency Top Five Activity
- Flow Meter Bags
- Gas Sequence Activity
- Guide, Teacher/Student
- Incandescent Bulbs
- Insulation Containers
- Lamp Bases
- LCD Thermometers
- Natural Gas Poster
- NEED Infobooks
- Safety Sort Activity
- Sample Student Efficiency Kit
- Source Team Match Up Activity
- Tile Sample
- Transformation Signs and Toys
- Watt About the Bulb Activity
- Wattmeters
- What Am I? Activity

RETURNING Teacher

- Carpet Square Sample
- Digital Thermometers
- Guide, Teacher/Student
- Insulation Containers
- Sample Energy Efficiency Kit
- Tile Sample
- Transformation Signs & Toys

Ohio's Learning Standards Energy Efficiency Programs

	Lesson 1 What is Energy?	Lesson 2 Insulation , Heating, and Cooling	Lesson 3 Water Heating	Lesson 4 Lighting	Lesson 5 Appliances and Machines	Lesson 6 What Have we Learned?
4th Grade						
Scientific Inquiry, Application and Scientific Ways of Knowing	x	x	x	x	x	x
Physical Science - Electricity, Heat and Matter						
Energy can be transformed from one form to another or can be transferred from one location to another	x	x	x	x	x	
Life Science						
Changes in an organism's environment are sometimes beneficial to its survival and sometimes harmful				x	x	
Mathematics						
Measurement and Data - solve problems involving measurement and conversion of measurements		x	x	x	x	
Represent and interpret data		x	x	x		
5th Grade						
Scientific Inquiry, Application and Scientific Ways of Knowing	x	x	x	x	x	x
Physical Science - Light, Sound and Motion						
Light and sound are forms of energy and behave in predictable ways	x			x	x	
Mathematics						
Convert like measurement units within a given measurement system			x	x	x	
Represent and interpret data		x	x	x		
Graph points on a coordinate plane to solve real-world and mathematical problems			x	x		
6th Grade						
Scientific Inquiry, Application and Scientific Ways of Knowing	x	x	x	x	x	x
Physical Sciences - Matter and Motion						
There are two categories of energy: kinetic and potential	x				x	
7th Grade						
Scientific Inquiry, Application and Scientific Ways of Knowing	x	x	x	x	x	x
Physical Science - Conservation of Mass and Energy						
Energy can be transformed or transferred but is never lost	x			x	x	
Energy can be transferred through a variety of different ways	x			x	x	
8th Grade						
Scientific Inquiry, Application and Scientific Ways of Knowing	x	x	x	x	x	x
Physical Science - Forces and Motion						
There are different types of potential energy	x		x			
9th - 12th grade Visit www.ohioenergy.org						

Program Overview

OEP Web Log on:

Name = your email as of 9/1 **Password** = your last name

Materials

LESSON	MATERIALS
1. What is Energy? * Forms of Energy * Energy Transformation with Toys * Energy Source Matching * Forms and Sources of Energy * Energy I Used Today * Coal Sequence * Efficiency vs. Conservation	NEED Infobooks Transformation Cards Toys Coal Sequence Energy Efficiency Top Five Source Team Match Up
2. Insulation/Heating/Cooling * Insulation Investigation * Temperature Investigation	Insulation Containers Masking tape Digital Thermometers Pitcher Insulating Materials What Am I? Rubber Bands Carpet square Ceramic tile Hot Water Timer LCD thermometers (if available)
3. Water Heating * Water Heating Investigation * Comparing EnergyGuide Labels	Digital Thermometers Flow Meter Bags Hot Water Gauges Natural Gas Scratch and Sniff (if available) Gas Sequence Safety Sort
4. Lighting * Lighting Investigation * Light Bulb Comparison * Facts of Light	Incandescent Bulb Fluorescent Bulb LED Bulb Lamps (3) Thermometers (3) Watt About the Bulb
5. Appliance and Machines * Appliances and Machines Investigation * The Environment and You	Watt meters Pluggable Appliances
6. What Have We Learned	

Checklist

TASK	DUE DATE	COMMENT
Confirm Student Count	September	Confirm early to receive kits in a timely manner
Student Kits Shipped	October/November	Count kits when received
Teach Lessons	September – April	Teach lessons as best fits your classroom
Home Installation Survey	April	Online survey (mail hard copy surveys)
Energy Portfolio (optional)	April 15	Document activities in an Energy Portfolio
Youth Energy Celebration (optional)	May	Student accomplishments are recognized at luncheon
Teacher Evaluation	May 15	Stipends mailed prior to end of school year

Lesson 1: What is Energy?

Overview

Part 1: This lesson reviews the ten sources and nine forms of energy. The Law of Conservation of Energy states that energy is neither created nor destroyed, it is simply transformed. A variety of materials will be used to trace the transformation of energy and the production of electricity. This lesson also identifies measures that allow homes to be more energy efficient and behaviors that conserve energy.

Depending on the prior knowledge of your students, you may want to spend additional time on these topics using the *Energy Infobooks* available at www.NEED.org at primary, elementary, intermediate, and secondary reading levels for your differentiated instructional needs.

Objectives

- Students will be able to list the 10 sources of energy.
- Students will be able to classify the 10 sources of energy as renewable or nonrenewable and kinetic or potential energy.
- Students will be able to list ways in which the sources are used.
- Students will be able to demonstrate how energy is transformed from one form to another.
- Students will be able to differentiate between energy efficiency and energy conservation, citing examples of each concept.

Materials

- Transformation Cards and Toys
- Energy Efficiency Top 5
- Coal Sequence
- NEED Infobooks

Masters

- *Where Does My Car Get Its Energy? (1-1)*

Student and Family Guide

- *Background Information*
- *Forms of Energy - Potential*
- *Forms of Energy - Kinetic*
- *Energy Transformation - Toys*
- *Energy Source Matching*
- *Forms and Sources of Energy*
- *The Energy I Used Today*
- *Efficiency vs. Conservation*
- *Home Activity: Household Rating Guide*
- *Assessment*
- *Connections*

Recommended Activities

- Energy Systems: www.phet.colorado.edu/ - Interactive site lets students see different energy forms at work.

Procedure

Introduction

1. Distribute one Student and Family Guide to each student.
2. Introduce the unit as a study of energy—what it is, where we get it, how we use it, how it is transformed and ways we can conserve it.

Forms of Energy

1. Introduce kinetic and potential energy with a review of the page in the Background Information for Lesson 1.
2. Define and provide examples for potential energy. Potential energy is stored energy. Examples include a stretched rubber band, food, ball held up in the air, etc.
3. Define and provide examples for kinetic energy. Kinetic energy is motion energy. Examples include a moving bike, light, heat and sound because they all travel.
4. Have student complete the *Forms of Energy* potential and kinetic charts.

Energy Transformation with Toys

1. Discuss with students that energy is the ability to do work.
2. List the major things energy does—**heat, light, sound, motion, growth,** and **powering technology**—have students give examples of each. Examples include: heat our houses, grow plants and animals, electronic devices, etc.
3. Demonstrate how the no-battery flashlight works using the Background Information page "Energy Transformations".
4. Review forms of energy using the Transformation Cards.
5. Trace the transformation of energy with each toy, using the Transformation Cards as a chemical equation on the "Energy Transformation - Toys" worksheet. See the sample at the top of the page.

Where Does My Car Get Its Energy?

1. Display or project the *Where Does My Car Get Its Energy? (1-1)* master.
2. Ask, "Where does a car get the energy it needs to move? "When 'gas pump' is named, uncover the picture.
3. Ask, "What fuel is being used by the car?" When 'gasoline' or 'diesel' is named, uncover the picture of the barrel. Discuss petroleum products such as plastics, nylon, synthetic carpets and gasoline.
4. Ask, "Where is petroleum found?" Petroleum is found trapped in rock formations, deep under land and oceans.
5. Ask, "How was petroleum formed?" Uncover the formation pictures. Petroleum was formed when tiny sea plants and animals died, were buried on the oceans' floors and were compressed under heat and pressure over hundreds of millions of years, turning them into oil (petroleum) and natural gas.
6. Ask, "Where did the sea plants and animals get the energy that was stored in them?" Uncover the top picture. Plants absorbed radiant energy from the sun and stored it in their cells as chemical energy.
7. Discuss that this is an example of an energy flow and/or transformation. The energy from the petroleum (stored chemical energy) was used to provide energy for the car to move—mechanical energy.

Energy Source Matching and Forms and Sources of Energy

1. Review the definitions for renewable and nonrenewable energy sources using the Lesson 1 Background Information.
2. Go to the *Energy Source Matching* worksheet in the Student and Family Guide. Instruct students to match each energy source with its definition. Review answers using the answer key in the Teacher Guide.
3. Instruct students to complete *Forms and Sources of Energy* worksheet. Review using the answer key in the Teacher Guide.

Energy I Used Today

1. Discuss how we use energy and list student responses.
2. Instruct the students to complete the activity *The Energy I Used Today* by circling the energy activities or devices they used in the last 24 hours.
3. Have students add the energy bucks they used to their lists and calculate their total energy bucks.
4. Discuss the total energy bucks students used. A total of under 80 is considered very good in terms of energy savings. Ask students which items they could cut out to reduce their use of energy.
5. Have students trace the transformation of energy for the activities in their day in the Transformation Column. See the sample at the top of the page.

Coal Sequence

1. Ask, "What is electricity? How is electricity produced?"
2. Review *Burning of Fossil Fuels to Generate Electricity* in the Lesson 1 Background Information to explain how coal, petroleum and natural gas produce electricity.
3. Have students complete the Coal Sequence Activity as a class using the directions included with the activity in the Classroom Kit.

Energy Efficiency Top Five

1. Review with students the activity *The Energy I Used Today*.
2. Ask students which of the activities use the most energy in the home?
3. Introduce the Top Five activity using the directions and script included in the Classroom Kit.
4. Have students guess the top five areas in the home that can be more energy efficient and save energy.
5. As students guess the answer, flip the corresponding card and read the description from the script.
6. When all five areas are determined, discuss the difference between efficiency and conservation:
    a. *Energy efficiency* is a way of managing energy consumption through technology. Something is more *energy efficient* if it delivers more services for the same or less energy input. (Example: CFL light bulb)
    b. *Energy conservation* is the reduction of energy consumption through elimination of waste and wise use. (Example: running the dishwasher only when it is full.)
7. Remind the class that energy efficiency and energy conservation can go hand in hand, for example, replacing an incandescent light bulb with an LED bulb is both conservation and energy efficient.
8. Have students complete the *Efficiency vs. Conservation* worksheet in the *Student and Family Guide*.

Optional: Energy Source Team Match Up

1. Use the instructions and materials in the Classroom Kit to explore the safety, environmental impact, economics and availability of the ten sources of energy.

Home Action Item and Wrap Up

1. Review the *Home Activity* instructions with students and assign a completion date.
2. Have students complete the *Assessment* and *Connections* activities in the *Student and Family Guide*.

LESSON 1

Background Information: What is Energy?

The United States uses a lot of **energy**—over two million dollars worth of energy per minute, 24 hours a day, 365 days a year. With just less than 4.5 percent of the world's population, we consume about 18.6 percent of the world's energy resources.

All of us use energy every day—for getting from one place to another, cooking, heating and cooling rooms, making products, lighting, heating water, and entertainment.

We use a lot of energy to make our lives comfortable, productive, and enjoyable. Most of that energy is from nonrenewable energy sources. It is important that we use our energy resources wisely.

Energy Efficiency and Conservation

The choices we make about how we use energy have environmental and economic impacts. There are many things we can do to use less energy and use it more wisely. These actions include both energy conservation and energy efficiency.

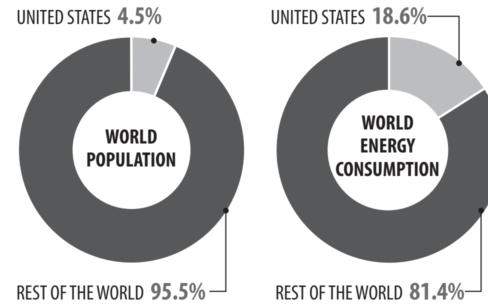
Energy conservation is any action or behavior that results in using less energy. Drying clothes outside on sunny days is an example of energy conservation. **Energy efficiency** focuses on technologies that use less energy to perform the same tasks or the same amount of work. Buying a dryer that uses less energy is an example of energy efficiency.

Who Uses Energy?

The U.S. Department of Energy uses categories to classify energy users—residential, commercial, industrial, electric power, and transportation. These categories are called the sectors of the economy.

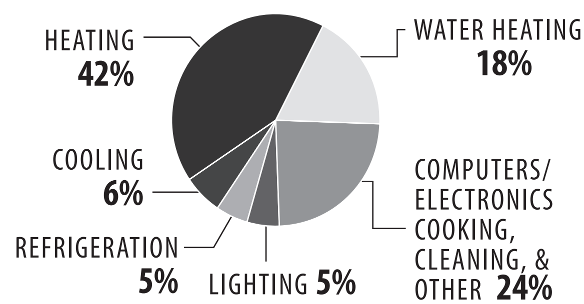
The residential sector includes houses, apartments, and other places where people live. The commercial sector includes schools, businesses, and hospitals. The residential and commercial sectors are put together because they use energy for similar tasks—for heating, air conditioning, water heating, lighting, and operating appliances.

Population Versus Energy Consumption, 2014



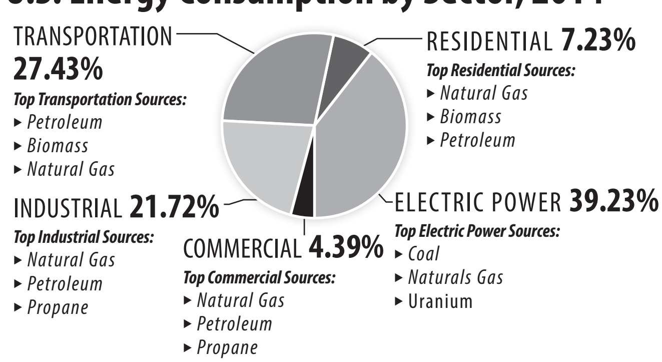
Data: Energy Information Administration

Home Energy Usage, 2014



Data: U.S. Department of Energy

U.S. Energy Consumption by Sector, 2014



The residential, commercial, and industrial sectors use electricity. This graph depicts their energy source consumption outside of electricity.

Data: Energy Information Administration

What Is Energy?

Energy makes change; it does things for us. It moves cars along the road and boats over the water. It bakes a cake in the oven and keeps ice frozen in the freezer. It plays our favorite songs and lights our homes. Energy makes our bodies grow and allows our minds to think. Scientists define energy as the ability to do work.

Forms of Energy

All forms of energy fall under two categories:

POTENTIAL

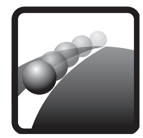
Stored energy and the energy of position (gravitational).

CHEMICAL ENERGY is the energy stored in the bonds between atoms in molecules. Gasoline and a piece of pizza are examples.

NUCLEAR ENERGY is the energy stored in the nucleus or center of an atom – the energy that holds the nucleus together. The energy in the nucleus of a plutonium atom is an example.

ELASTIC ENERGY is energy stored in objects by the application of force. Compressed springs and stretched rubber bands are examples.

GRAVITATIONAL POTENTIAL ENERGY is the energy of place or position. A child at the top of a slide is an example.



KINETIC

The motion of waves, electrons, atoms, molecules, and substances.

RADIANT ENERGY is electromagnetic energy that travels in transverse waves. Light and x-rays are examples.

THERMAL ENERGY or heat is the internal energy in substances – the vibration or movement of atoms and molecules in substances. The heat from a fire is an example.

MECHANICAL ENERGY is the movement of a substance from one place to another. Wind and moving water are examples.

SOUND ENERGY is the movement of energy through substances in longitudinal waves. Echoes and music are examples.

ELECTRICAL ENERGY is the movement of electrons. Lightning and electricity are examples.

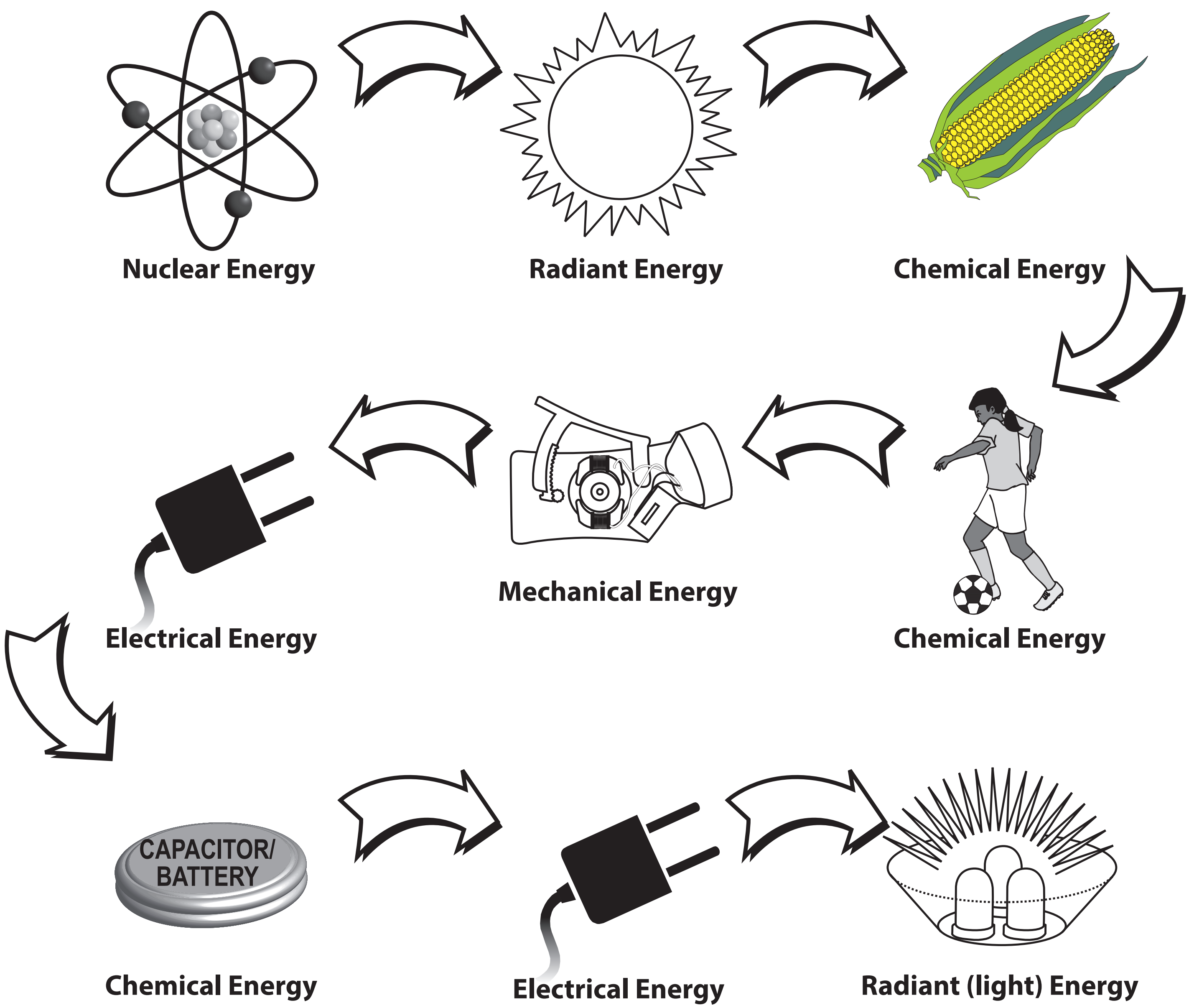
Energy Transformations

Conservation of Energy

Your parents may tell you to conserve energy. "Turn off the lights," they say. To scientists, **energy conservation** is not just about turning off the lights. The **Law of Conservation of Energy** says that energy is neither created nor destroyed. When we use energy, it doesn't disappear. We change one form of energy into another form.

A car engine burns gasoline, converting the chemical energy in gasoline into motion energy. Solar cells change radiant energy into electrical energy. Energy changes form, but the total amount of energy in the universe stays the same.

Energy Transformations for a Hand Generated Flashlight



LESSON 1: BACKGROUND INFORMATION

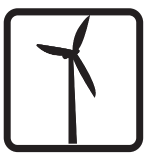
Sources of Energy

We use many different energy sources to do work for us. They are classified into two groups—renewable and nonrenewable.

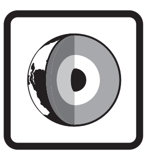
In the United States, most of our energy comes from nonrenewable energy sources. Coal, natural gas, petroleum, propane, and uranium are nonrenewable energy sources. They are used to make electricity, heat our homes, move our cars, and manufacture all kinds of products. These energy sources are called nonrenewable because their supplies are limited. Petroleum, a fossil fuel, for example, was formed hundreds of millions of years ago from the remains of ancient sea plants and animals. We can't make more crude oil deposits in a short time.

Renewable energy sources include biomass, geothermal energy, hydropower, solar energy, and wind energy. They are called renewable because they are replenished in a short time. Day after day, the sun shines, the wind blows, and the rivers flow. We use renewable energy sources mainly to make electricity.

RENEWABLE energy sources are replenished in a short period of time.

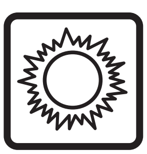


WIND is energy from moving air.



GEOTHERMAL energy is heat from within the earth.

HYDROPOWER is energy that comes from the force of moving water.



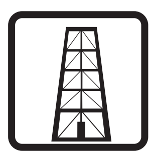
SOLAR energy is energy from the sun.

BIOMASS is any organic matter (anything that was once alive) that can be used as an energy source such as wood, crops, and yard waste.

NONRENEWABLE energy sources are limited since it takes a very long time to replenish their supply.

COAL is a solid, black fossil fuel formed from the remains of plants that lived and died millions of years ago.

NATURAL GAS is a colorless, odorless fossil fuel made mostly of methane.

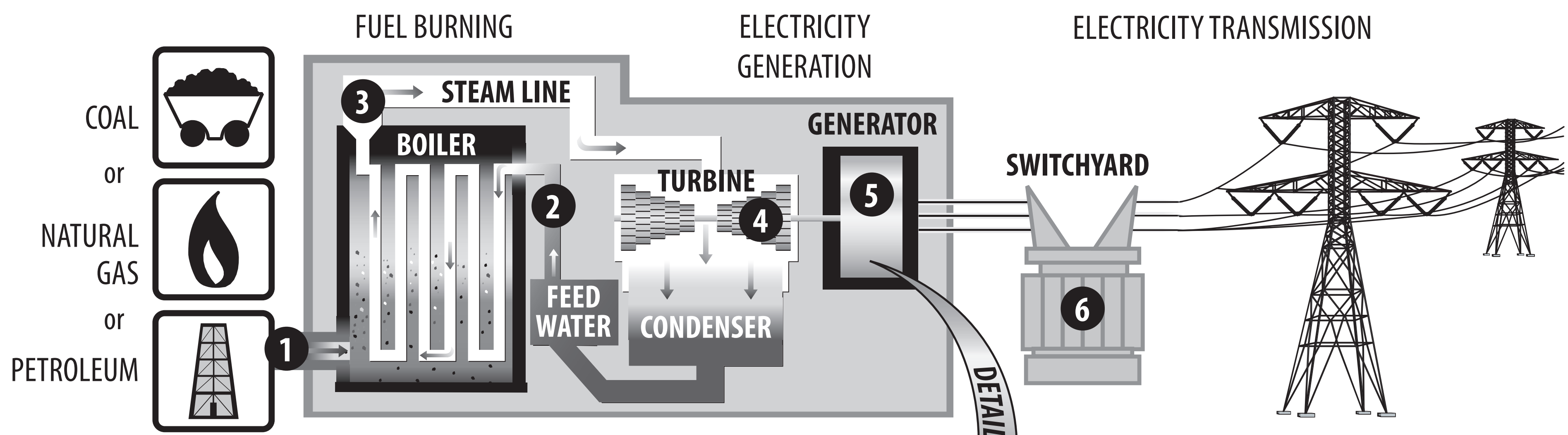


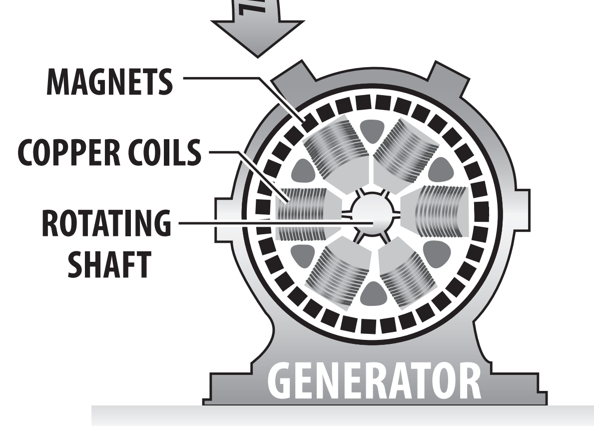
PETROLEUM is a fossil fuel that looks like a black liquid. It is also known as crude oil.

PROPANE is a fossil fuel refined from natural gas and petroleum.

URANIUM is the fuel used by most nuclear power plants. During nuclear fission, atoms are split apart to form smaller atoms, which releases energy.

Burning Fossil Fuels to Generate Electricity





1. A fossil fuel is fed into a boiler, where it is burned to release thermal energy.

2. Water is piped into the boiler and heated, turning it into steam.

3. The steam travels at high pressure through a steam line.

4. The high pressure steam turns a turbine, which spins a shaft inside a generator.

5. Inside the generator, the shaft spins coils of copper wire inside a ring of magnets. This creates an electric field, producing electricity.

6. Electricity is sent to a switchyard, where a transformer increases the voltage, allowing it to travel through the electric grid.

Industrial Sector

Manufacturing the goods we use every day consumes an enormous amount of energy. The industrial sector of the economy consumes almost one-third of the nation's energy. In industry, energy efficiency and conservation are driven by economics—money. Manufacturers know that they must keep their product costs low so people will buy them.

Since energy is one of the biggest costs in many industries, manufacturers must use as little energy as possible. Their demand for energy efficient equipment has resulted in many new technologies in the last decades. Consumers can have an effect on industrial energy use through the product choices we make and what we do with the packaging and the products we no longer use.

A Consumer Society

Not only is America a consumer society, it is also a 'throw away' society. Americans produce more trash than any other developed country. The average person throws away approximately 1,600 pounds of trash a year!

The best way for consumers to reduce the amount of energy used by industry is to avoid buying unnecessary products and to repair and reuse items wherever possible. Buying only those items you need, as well as reusing and recycling products, can reduce energy use in the industrial sector. The 4 R's of an energy-wise consumer are easy to put into practice. Managing waste saves money, energy, and natural resources, and helps protect the environment.

Reduce

Buy only what you need. Buying fewer goods means less to throw away. It also means fewer goods are produced and less energy is used to manufacture them. Buying goods with less packaging also reduces the amount of waste and the amount of energy used.

Reuse

Buy products that can be used more than once. If you buy things that can be reused rather than disposable items that are used once and thrown away, you save natural resources. You will also save the energy used to make them, and reduce the amount of landfill space needed to contain the waste. Savings also result when you buy things that are durable. They may cost more, but they last a long time and do not need to be replaced often, saving money and energy.

Repair

Many people throw away products when they break and buy new ones. Many of these products could be easily and cheaply repaired. Always consider repairing a product before throwing it away. It saves energy, money, and natural resources.

Recycle

Make it a priority to recycle all materials that you can. Using recycled material to make new products almost always consumes less energy than using new materials. Recycling reduces energy needs for mining, refining, and many other manufacturing processes.

Recycling steel saves 75 percent of the energy needed to make products from raw iron ore. Recycling aluminum cans saves 92 percent of the energy required to produce aluminum from bauxite. Many other products can also be recycled and contribute to savings in energy and resources.

Recycling is only part of the process to save energy. Consumers also need to make an effort to buy recycled goods. Many products now have labels that tell consumers how much recycled material they contain.

Energy Sustainability

Efficiency and conservation are key components of **energy sustainability**—the concept that every generation should meet its energy needs without compromising the needs of future generations. Sustainability focuses on long-term actions that make sure there is enough energy to meet today's needs as well as tomorrow's.

Sustainability also includes the development of new clean technologies for using fossil fuels, promoting the use of renewable energy sources, and encouraging policies that protect the environment.

LESSON 1

Forms of Energy

Energy can be stored. Stored energy is called potential energy.

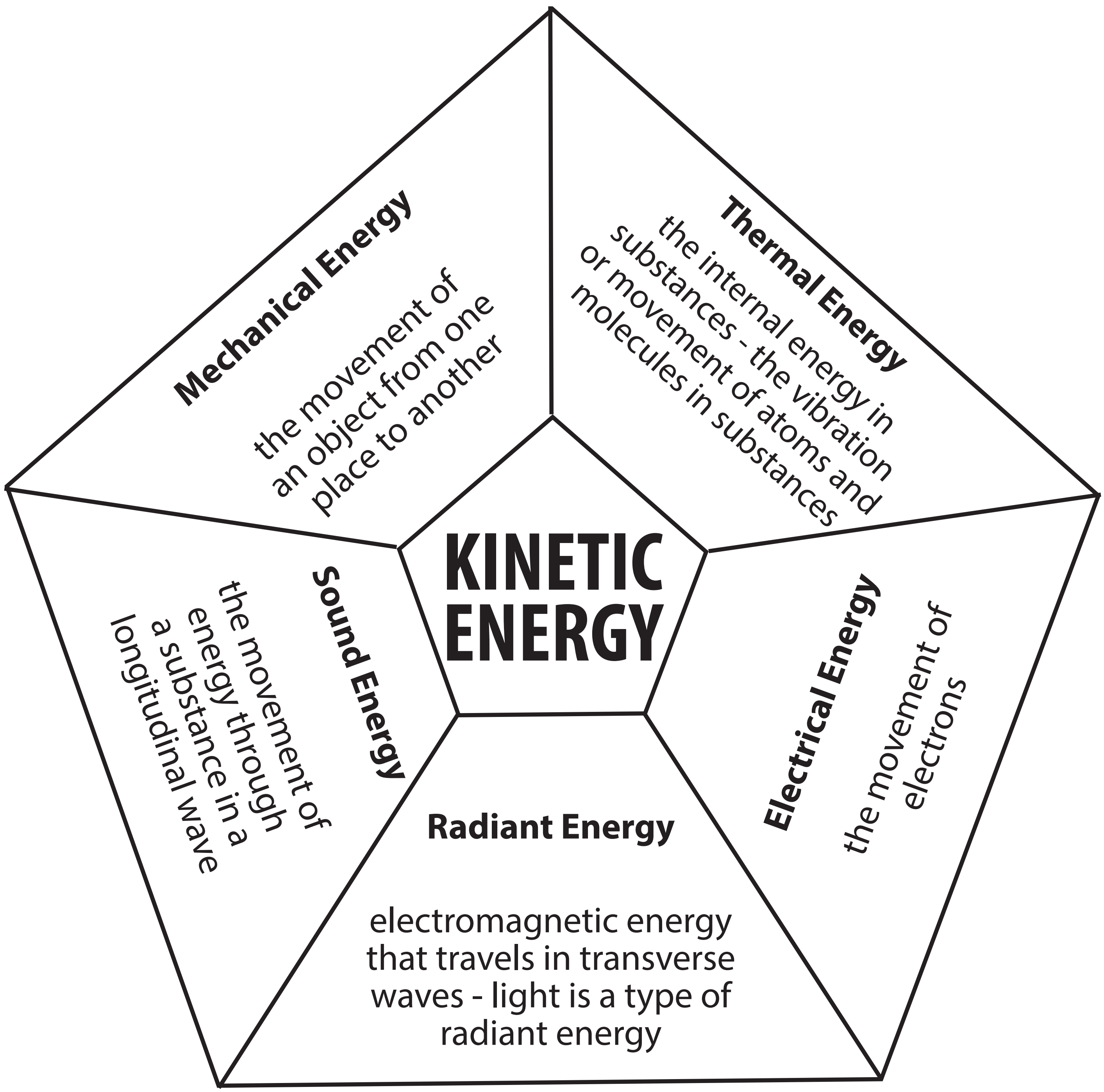
POTENTIAL ENERGY

Gravitational Potential Energy	**Elastic Energy**
the energy of place or position	the energy stored in compressed or stretched objects
Chemical Energy	**Nuclear Energy**
the energy stored in the bonds between molecules	the energy stored in the nucleus of an atom - the energy that holds the nucleus together

LESSON 1

Forms of Energy

Energy can be in motion. Motion energy is called kinetic energy.



LESSON 1

Energy Transformation - Toys

Energy cannot be created or destroyed. It can only change from one form to another.

Using the Transformation Cards, show how energy has been transformed by each of the toys. Look at the Toaster example below.

M	R	C	N	E	T	+	→
Mechanical	Radiant	Chemical	Nuclear	Electrical	Thermal	Plus	Transforms to

Toaster

M	+	E	→	T	+	R

For a toaster, mechanical energy (pushing down the lever) + electrical energy (electricity from the outlet) is transformed (→) into thermal (heat) and radiant (light) energy.

Dynamo Flashlight

M Mechanical	→	E Electrical	→	R Radiant	+	S Sound	+	T Thermal

Glow Stick

M Mechanical	+	C Chemical	→	R Radiant

Solar Toy

R Radiant	→	E Electrical	→	M Mechanical	+	S Sound

Toy Vehicle

C Chemical	→	E Electrical	→	M Mechanical	+	S Sound	+	R Radiant

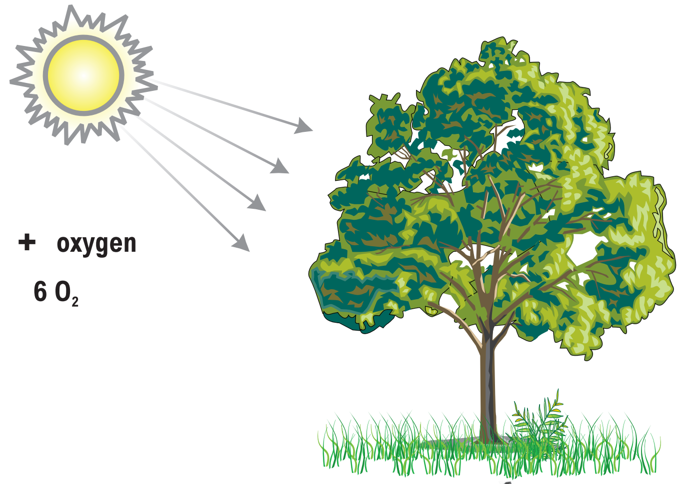
Where Does My Car Get Its Energy?

1 PHOTOSYNTHESIS

In the process of photosynthesis, plants convert radiant energy from the sun into chemical energy in the form of glucose (or sugar).

water + carbon dioxide + sunlight → glucose + oxygen

$$6\ H_2O + 6\ CO_2 + \text{radiant energy} \longrightarrow C_6H_{12}O_6 + 6\ O_2$$



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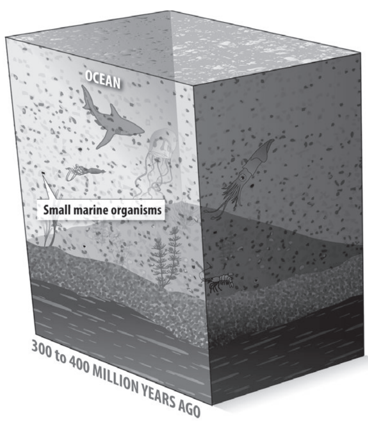
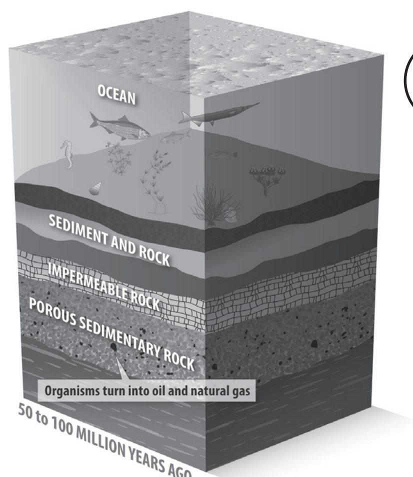


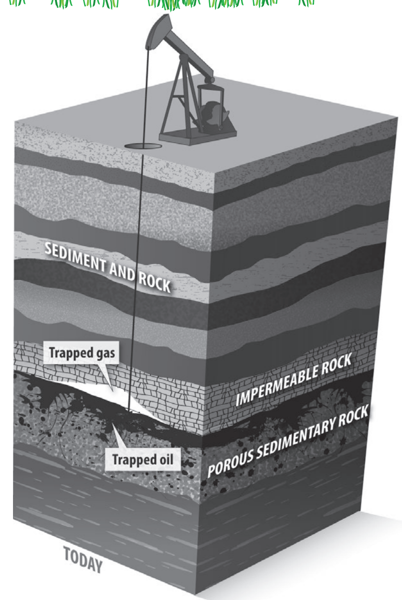
Tiny sea plants and animals died and were buried on the ocean floor. Over time, they were covered by layers of sediment and rock.

3



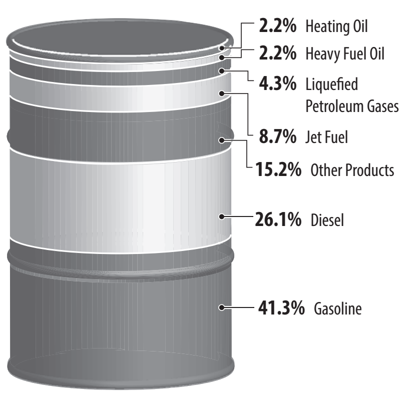
Over hundreds of millions of years, the remains were buried deeper and deeper. The enormous heat and pressure turned them into petroleum and natural gas.

4



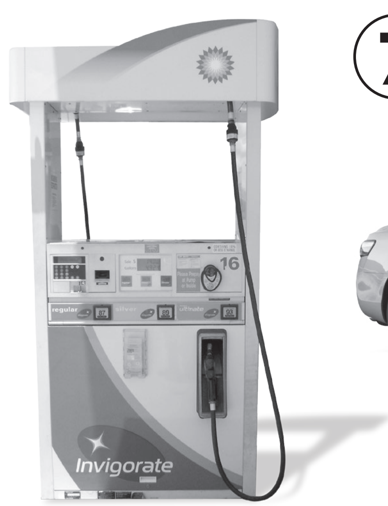
Today, we drill down through the layers of sedimentary rock to reach the rock formations that contain petroleum and natural gas deposits.

5 Products Produced From a Barrel of Oil, 2014



Data: Energy Information Administration

6



7

Energy Source Matching

Write the number of the energy source on the line next to its definition.

1. Petroleum	9	**Black rock burned to make electricity.**
2. Wind	7	**Energy from heat inside the Earth.**
3. Biomass	8	**Energy from flowing water.**
4. Uranium	3	**Energy from wood, waste, and garbage.**
5. Propane	2	**Energy from moving air.**
6. Solar	4	**Energy from splitting atoms.**
7. Geothermal	5	**Portable fossil fuel used in grills.**
8. Hydropower	1	**Fossil fuel for cars, trucks, and jets.**
9. Coal	10	**Fossil fuel gas moved by pipeline.**
10. Natural Gas	6	**Energy in waves from the sun.**

Forms and Sources of Energy

In the United States we use a variety of resources to meet our energy needs. Use the information below to analyze how each energy source is stored and delivered.

1 Using the information from the *Forms of Energy* charts and the graphic below, determine how energy is stored or delivered in each of the sources of energy. Remember, if the source of energy must be burned, the energy is stored as chemical energy.

NONRENEWABLES

Petroleum ***CHEMICAL***

Natural Gas ***CHEMICAL***

Coal ***CHEMICAL***

Uranium ***NUCLEAR***

Propane ***CHEMICAL***

RENEWABLES

Biomass ***CHEMICAL***

Hydropower ***MECHANICAL***

Wind ***MECHANICAL***

Solar ***RADIANT***

Geothermal ***THERMAL***

2 Look at the U.S. Energy Consumption by Source graphic below and calculate the percentage of the nation's energy use that each form of energy provides.

What percentage of U.S. energy is provided by each form of energy?

Mechanical ***4.2%***

Chemical ***86.8%***

Radiant ***0.4%***

Thermal ***0.2%***

Nuclear ***8.3%***

What percentage of the nation's energy is provided by

Nonrenewables ***90.3%***

Renewables ***9.6%***

U.S. Energy Consumption by Source, 2014

NONRENEWABLE

PETROLEUM	34.9%	*Uses: transportation, manufacturing*
NATURAL GAS	27.5%	*Uses: heating, manufacturing, electricity*
COAL	18.0%	*Uses: electricity, manufacturing*
URANIUM	8.3%	*Uses: electricity*
PROPANE	1.6%	*Uses: heating, manufacturing*

RENEWABLE

BIOMASS	4.8%	*Uses: heating, electricity, transportation*
HYDROPOWER	2.5%	*Uses: electricity*
WIND	1.7%	*Uses: electricity*
SOLAR	0.4%	*Uses: heating, electricity*
GEOTHERMAL	0.2%	*Uses: heating, electricity*

*Total does not add to 100% due to independent rounding.
Data: Energy Information Administration

LESSON 1

The Energy I Used Today

Circle the things you used or did today in the left column. For each item circled, write the number of Energy Bucks (in parenthesis) in the Energy Bucks column. Add them together to find your Total Energy Bucks Used. List the transformation of energy in the right column. The first example has been completed for you.

What device woke me up this morning?	ENERGY BUCKS	TRANSFORMATION
Alarm Clock/Radio/Cell phone (2 bucks)	2	E ⟶ S
What devices were used to make my breakfast?		
Microwave (2 bucks)	2	E⟶ R ⟶ T+M
Stove/Oven (5 bucks)	5	E ⟶ T or C ⟶ T
Toaster Oven/Toaster (3 bucks)	3	E⟶R+T
Refrigerator (3 bucks)	3	E⟶T
What devices did I use as I got ready for school this morning?		
Air Conditioning/Heating (10 bucks)	10	E⟶M+T or C⟶T+M
Radio/CD Player/MP3 Player/iPod (2 bucks)	2	E ⟶S+T
Gaming System (3 bucks)	3	E⟶S+T+R
TV/DVD Player (3 bucks)	3	E⟶S+T+R
Shower/Bath (3 bucks)	3	E⟶T or C⟶T
Hair Dryer (3 bucks)	3	E⟶ T+M+S
Curling Iron/Curlers/Flat Iron (3 bucks)	3	E⟶T
Telephone/Cell Phone (2 bucks)	2	E⟶S+R
Computer (3 bucks)	3	E⟶R+S+T
iPad/Tablet (2 bucks)	2	E⟶R+S+T
What rooms had lights turned on this morning?		
Bedroom (2 bucks)	2	E⟶R+T
Bathroom (2 bucks)	2	E⟶R+T
Kitchen (2 bucks)	2	E⟶R+T
Family Room (2 bucks)	2	E⟶R+T
Other (2 bucks)	2	E⟶R+T

How did I get to school today?	ENERGY BUCKS	TRANSFORMATION
Walk (0 bucks)	0	C ⟶ M
Bicycle (0 bucks)	0	C ⟶ M
School Bus (1 buck)	1	C ⟶ M
Carpool (2 bucks)	2	C ⟶ M
Family Vehicle (5 bucks)	5	C ⟶ M

What devices did I use after school yesterday?		
Air Conditioning/Heating (10 bucks)	10	E ⟶ M+T or C ⟶ M+T
Travel in Vehicle (5 bucks)	5	C ⟶ M
Lights (2 bucks)	2	E ⟶ R+T
Computer (3 bucks)	3	E ⟶ R+T+S
iPad/Tablet (2 bucks)	2	E ⟶ R+S+T
Gaming System (3 bucks)	3	E ⟶ R+T+S
Radio/CD Player/MP3 Player/iPod (2 bucks)	2	E ⟶ S
TV/DVD Player (3 bucks)	3	E ⟶ S+R+T
Telephone/Cell phone (2 bucks)	2	E ⟶ R+S

What devices were used at home last night?		
Air Conditioning/Heating (10 bucks)	10	E ⟶ M+T or C ⟶ M+T
Microwave (2 bucks)	2	E ⟶ R ⟶ T+M
Stove/Oven (5 bucks)	5	E ⟶ T or C ⟶ T
Toaster Oven/Toaster (3 bucks)	3	E ⟶ T+R
Refrigerator (3 bucks)	3	E ⟶ T
Grill (2 bucks)	2	C ⟶ T+R
Lights (2 bucks)	2	E ⟶ T+R
TV/DVD Player (3 bucks)	3	E ⟶ R+T+S
Gaming System (3 bucks)	3	E ⟶ R+T+S
Shower/Bath (3 bucks)	3	E ⟶ T or C ⟶ T
Hair Dryer (3 bucks)	3	E ⟶ T+M+S
Telephone/Cell Phone (2 bucks)	2	E ⟶ R+S
Computer (3 bucks)	3	E ⟶ R+S+T
iPad/Tablet (2 bucks)	2	E ⟶ R+S+T
Radio/CD Player/MP3 Player/iPod (2 bucks)	2	E ⟶ S

Total Energy Bucks Used ____________

LESSON 1

Efficiency vs. Conservation

Energy efficiency and conservation are both important ways to save energy. Write the definitions for each in the top boxes and examples in the bottom boxes.

EFFICIENCY

Technology that uses less energy to do the same amount of work

CONSERVATION

Behavior that uses less enegry

VS

EXAMPLES

LED bulbs

Hybrid cars

Low flow shower heads

EXAMPLES

Lowering the thermostat temperature in the winter

Walking or car pooling

Turning off the lights

LESSON 1

Home Activity

Household Rating Guide: How to Rate Your Family's Energy Use

How much energy does your family use every month? Are your family members aware of the energy they use? Do they know about ways to save energy at home by changing their actions and taking simple steps to make the house more energy efficient?

This guide can help your family save energy in five energy areas:

- Living Efficiently
- Home Heating and Cooling
- Water Heating
- Household Appliances and Electronics
- Lighting

Start by finding your family's Household Energy Conservation Rating. First, read the statements in each energy section carefully. Decide how much or how little your family's energy use fits the statements and then rate your family's energy use by choosing a number from 0 to 5 for each statement in the first five categories.

For example, if your family never makes an effort to save energy in a category, choose 0. But if your family always makes an effort, choose 5. (If some members of your household are more energy conscious than others, choose the number you feel represents the average for your family.)

Please be honest with your responses. Do not be embarrassed if you give your family low ratings; most American households would receive ratings of 0, 1, or 2. The important thing is to honestly evaluate your current energy consumption and work to reduce it.

Living Efficiently

1. We have had an energy audit of our house.
Your local utility will send someone to your house to perform an audit and show you where your house is wasting energy and what you can do to correct it.
Yes No

2. We have eliminated drafts around windows and doors with caulking and weatherstripping.
Proper caulking and weatherstripping can cut fuel costs by up to 10 percent.
Yes No

3. We have the proper amount of insulation in the attic and walls.
If you need to add insulation, the cost will be made up in lower utility bills.
Yes No

4. We have insulated our hot water tank and piping.
A well-insulated tank can save $10-20 in energy costs over a 12-month period.
Yes No

5. We have low-flow shower heads.
These easy-to-install devices save energy and provide adequate shower pressure.
Yes No

6. When buying new appliances, we compare EnergyGuide labels and buy energy efficient models.
The most energy efficient new appliances cost a little more, but save money and energy over their operating life.
Yes No

7. When purchasing vehicles, fuel mileage is one of our most important considerations.
A fuel efficient vehicle can save thousands of dollars in fuel costs over the life of the vehicle.
Yes No

Household Rating Guide

Home Heating and Cooling

1. We inspect windows and doors, and make repairs as necessary, to make sure they are airtight.
Caulking and weatherstripping can deteriorate over time. 25% of home heat loss is around windows and doors.

Never 0 1 2 3 4 5 Always

2. We inspect the ductwork to make sure there are no cracks or openings.
Openings or cracks in the ducts can allow conditioned (heated or cooled) air to escape into the attic and crawl spaces.

Never 0 1 2 3 4 5 Always

3. We clean or replace system filters as recommended.
Keeping filters clean provides more efficient heating and cooling.

Never 0 1 2 3 4 5 Always

4. In winter, we dress warmly and set the thermostat at 68 degrees or lower during the day and 60 degrees or lower at night. *Setting the thermostat back 8 degrees for 8 hours a day can save 10%.*

Never 0 1 2 3 4 5 Always

5. In the summer, we dress lightly and set the thermostat at 78 degrees or higher.
This temperature is considered the most comfortable for humans if fans are used to circulate the air.

Never 0 1 2 3 4 5 Always

6. We keep windows and doors closed when the heating or air conditioning system is operating.
Having windows and doors open makes your heating or air conditioning system work harder.

Never 0 1 2 3 4 5 Always

Water Heating

1. The water heater thermostat is always set at 120 degrees.
Most hot water heaters are set much higher than necessary. You can save up to 10 percent on your energy bill by setting the temperature at 120 degrees.

Never 0 1 2 3 4 5 Always

2. We inspect the insulation on our hot water tank and piping, and make repairs as necessary.
Insulation can come loose or deteriorate over time.

Never 0 1 2 3 4 5 Always

3. We use cold water whenever hot water is not necessary (e.g., washing clothes, rinsing dishes, running disposal). *Using cold water saves energy and most tasks do not require hot water.*

Never 0 1 2 3 4 5 Always

4. We take short showers and fill the tub with only the water we need.
Short showers use less energy than baths.

Never 0 1 2 3 4 5 Always

5. We fill the sink to wash dishes rather than running the water, and use the short cycle on the dishwasher.
Running water to wash dishes and long dishwasher cycles use a lot of water and energy.

Never 0 1 2 3 4 5 Always

Household Rating Guide

Household Appliances and Electronics

1. We turn off appliances and electronics, such as televisions, when not in use.
Many appliances continue to draw energy when they are in the off position.

Never 0 1 2 3 4 5 Always

2. We preheat the oven for only five minutes or not at all.
It also saves energy to cook several dishes at once to make maximum use of this concentrated heat.

Never 0 1 2 3 4 5 Always

3. When baking, we keep the oven door closed rather than opening it often to look inside and use a timer. *An open oven door lets valuable heat escape.*

Never 0 1 2 3 4 5 Always

4. Whenever possible, we use a toaster oven or microwave instead of a regular oven.
These smaller appliances save energy for most cooking jobs.

Never 0 1 2 3 4 5 Always

5. We inspect refrigerator and freezer door seals often to make sure they are airtight.
Insert a piece of paper halfway in the door. If you can pull the paper out easily, the seal is not airtight.

Never 0 1 2 3 4 5 Always

6. We use the energy-saver feature on the dishwasher, allowing the dishes to air dry.
Producing heat to dry dishes uses a lot of energy.

Never 0 1 2 3 4 5 Always

Lighting

1. We turn off indoor and outdoor lights when they are not needed.
Many people leave lights on without thinking—wasting energy.

Never 0 1 2 3 4 5 Always

2. We use natural lighting whenever we can by opening blinds/shades/curtains.
Natural lighting is free to use.

Never 0 1 2 3 4 5 Always

3. We use energy-efficient lights in garages and work areas that need lots of light.
A 40-watt fluorescent lamp provides 50-80 lumens per watt, while a 60-watt incandescent provides only 13-15 lumens per watt. You save energy and get more light from fluorescents.

Never 0 1 2 3 4 5 Always

4. We replace burned-out incandescent light bulbs with compact fluorescent (CFL) bulbs or light emitting diodes (LED).
New CFLs and LEDs fit conventional light fixtures. They are more expensive to buy, but last ten times longer and use one-fourth or less of the energy of incandescent bulbs, saving you money and energy in the long run.

Never 0 1 2 3 4 5 Always

5. We keep lamps and light fixtures clean because dirt absorbs light.
Get the best use of lighting by dusting regularly.

Never 0 1 2 3 4 5 Always

LESSON 1 – What is Energy?

ASSESSMENT

1. The energy in petroleum, natural gas, coal and biomass is stored as __________?

   a. thermal energy **b. chemical energy** c. kinetic energy d. sound energy

2. The energy source that provides most of our transportation needs is __________?

   a. wind **b. petroleum** c. propane d. coal

3. Which energy source is a type of mechanical energy?

   a. uranium b. geothermal c. solar **d. hydropower**

4. Which conservation behavior would save the most energy in your home?

   a. turn off an LED light **b. open the window instead of turning on the air conditioning** c. driving to school d. turn off the TV for one hour

5. What is the most energy efficient way to dry your hair? Explain.

   The most energy efficient way to dry your hair would be to allow it to air dry because no electricity or other form of energy is needed.

6. You ate a banana for breakfast. List the transformation steps involved in giving you energy for your morning at school.

   Chemical (food) → Mechanical (motion). Students may also include transportation, appliances, etc. used in the morning.

7. Appliances are one of the "Top Five" energy users in your home. Describe two ways you can conserve energy with the appliances you use most at home.

   Responses will vary.

Connections *(pg 22, Student and Family Guide)*

1. If you could decide on the source of energy used to generate electricity for your community, which energy source(s) would you choose and why?
2. Using the forms of energy, describe the transformation of energy in a car.
3. After completeing *The Energy I Used Today* and the *Household Rating Guide*, list 5 things you would change to save energy.

Lesson 2: Insulation, Heating, and Cooling

Overview

Part 1: This lesson helps students understand that heat transfers from areas of high temperature to areas of low temperature and how insulators and conductors impact heat transfer. Students will learn how to reduce heat transfer in their homes using simple, energy saving measures.

Part 2: Heating and cooling systems use more energy than any other systems in the home. This lesson will focus on the difference between heat and temperature. Students will learn how to use heating and cooling systems efficiently.

Objectives

Part 1:

- Students will be able to identify that heat transfers from areas of high temperature to areas of lower temperature.
- Students will be able to explain that a thermal insulator reduces heat transfer and a thermal conductor transfers heat easily.
- Students will be able to identify a material as an insulator or conductor.
- Students will be able to explain the importance of proper levels and placement of insulative materials.

Part 2:

- Students will be able to explain the difference between heat and temperature.
- Students will be able to measure temperature accurately using appropriate tools and converting units when necessary.
- Students will be able to explain the importance of properly regulating temperature when considering efficiency and conservation.

Part 1: Insulation Investigation

Materials

- 2 Insulation containers per group
- 2 Lab thermometers per group
- Pitcher (provided by teacher)
- Insulating materials (aluminum foil, bubble wrap, cotton sock, etc. provided by teacher)
- 1 Rubber band per group
- Hot water (120-150°F)
- Masking tape
- Ceramic tile with attached thermometer
- Carpet sample with attached thermometer
- Timer or watch
- "What Am I" activity

Masters

- *Heat Transfer* (2-1)
- *Insulators vs. Conductors* (2-2)
- *Insulation Investigation* (2-3)

Home Energy Efficiency Kit Materials

- Weather stripping
- Door sweep (if available)
- Draft stoppers (if available)

Student and Family Guide

- *Background Information*
- *Insulation Investigation*
- *Temperature Investigation*
- *Home Activity*
- *Assessment*
- *Connections*

Preparation

- Prepare by setting up lab stations – each with 2 insulation containers, 2 thermometers, 2 rubber bands, one of the insulating materials and tape. Make sure you have a source for hot water, a pitcher to dispense it, and a timer.

✔ Procedure

1. Introduce the topic by discussing the direction of heat transfer and having students read the Lesson 2 Background Information. Ask, "On a cold winter day, what will happen to energy if you open the door of your home?" (Energy will flow from where it's warmer inside the house to where it is colder outside the house. Thermal energy (heat) always moves from an area of greater energy to lesser energy until equilibrium is achieved. In other words, heat moves from HOT to COLD until the amount of energy is equal.)

2. Display the *Heat Transfer (2-1)* master. Have students identify which direction the heat will travel for each image. Draw arrows to show the direction of heat transfer if you have smart board technology available. (Heat always travels from hot to cold, so it would travel from the hot coffee out to the air, from the air into the glass of ice water, etc.)

3. Show students the tile and carpet squares. Have one or more students touch both the tile and carpet. (The tile should feel cooler). Explain that both materials have been in the same room and are the same temperature. Show the thermometers on the back of each. The tile feels cooler because heat is transferred from our warm hands to the cooler tile. The tile is a conductor – it transfers heat easily. The carpet has lots of air spaces and resists the transfer of heat from our warm hand. The carpet is an example of an insulator. A thermal insulator is a material that reduces the rate of heat transfer.

4. Display the *Insulators vs. Conductors* (2-2) master. Have students identify which images are conductors and which images are insulators. (Conductors: frying pan, metal spoon. Insulators: fiberglass insulation, weather stripping, feather.)

5. Discuss why thermal insulators and conductors are important in the home. Go to the "Major Sources of Air Leaks" graphic in the Lesson 2 Background Information and discuss places air and heat can leak in the home. Using the diagram discuss the areas of a home that should be insulated. Discuss which direction heat would travel during the winter and the summer. (Heat travels out of the warm house in the winter and into the air conditioned house in the summer.)

6. Go to the *Insulation Investigation* in the *Student and Family Guide*. Review the procedure with the students.

7. Assign each group to a lab station.

8. Discuss the different insulating materials they will be investigating and have each group hypothesize which materials are the best insulators. Groups should rank the materials from 1 to 5, with 1 being the best insulator. Record the materials and the class hypotheses on the *Insulation Investigation* (2-3) master.

9. Instruct the groups to insulate the sides of one of their cans with the materials they have been provided.

10. Fill all of the cans with the same amount of hot water (approximately two-thirds full), and instruct the students to replace the tops and insert the thermometers according to the procedure.

11. Begin timing when all of the groups are ready. Have the groups record the beginning temperatures, then call out the time at one minute intervals for them to record the temperatures of both cans.

12. After 10 minutes, have the students calculate the difference between the beginning temperature and the ending temperature of each can and record it in the delta (ΔT) column of the chart on their investigation worksheet.

13. Instruct the students to graph their results.

14. Display the *Insulation Investigation* (2-3) master and record the results of the group.

15. Compare the groups' hypotheses with the results.

16. Discuss the responses to the lab questions.

17. Optional: Complete "What Am I" activity using instructions and cards in the Classroom Kit. Students match the names of insulating materials with their descriptions.

Part 2 Temperature Investigation

Materials

- Digital thermometer or LCD thermometers

Masters

- *Heat vs. Temperature* (2-4)
- *Temperature Guide* (2-5)

Student and Family Guide

- *Temperature Investigation*
- *Home Activity*
- *Assessment*
- *Connections*

Home Energy Efficiency Kit Materials

- LCD thermometer (if available), or paper copy of the *Thermostat Temperature Guide* in the Student and Family Guide page 27.

Preparation

- Prior to the lesson, arrange to have someone from the maintenance or facilities staff show the students the HVAC (Heating, Ventilation, and Air Conditioning) system and answer questions about the energy sources that fuel the system(s).

✔ Procedure

1. Display the *Heat vs. Temperature (2-4)* master and ask students to identify which images have more heat energy. Review the Heat and Temperature section of the Lesson 2 Background Information. Discuss that heat or thermal energy is the energy from moving molecules, and anything with molecules has heat. Even cold things, like ice sculptures, have heat or thermal energy. The molecules of cold things are just moving slower. The glacier has more molecules than the match, so even though it is much colder it has more heat energy. Although both beakers have the same temperature, the beaker with more water has twice the amount of heat because it has twice the amount of molecules.
2. Discuss that temperature is a measure of the "hotness" or "coldness" of an object. It measures the average kinetic energy of the molecules.
3. Remind students that heating and cooling homes accounts for the largest percentage of home energy costs.
4. Have the students inspect the school HVAC system with someone from the maintenance or facilities staff. Ask the staff member: Which system is in operation (heating or cooling)? What energy source fuels the heating system? What energy source fuels the cooling system?
5. Go to the *Temperature Investigation* in the Student Guide. Review the questions and have students record their hypotheses. Direct students to the *Thermostat Temperature Guide* on that worksheet.
6. Display the *Temperature Guide (2-5)* master and explain how to read it in both heating and cooling seasons. For example, 72ºF wastes 20% in the winter (heating).
7. Review the *Temperature Investigation* activity with the students and have them get into their groups. Provide each group with a thermometer for measuring temperature.
8. Instruct the students to complete the activity.
9. Review the results with the students using the *Temperature Guide (2-5)* master.
10. Discuss whether any action should be taken if temperatures are not within energy saving ranges.

✔ Home Action Item and Wrap Up

1. Review the *Home Activity* with the students and assign a completion date.
2. Give each student their weather stripping, door sweep (if available), draft stopper (if available) and LCD thermometer (if available).
3. Have students complete the *Assessment* and *Connections* activities in the *Student and Family Guide*.

Background Information: Insulation, Heating, and Cooling

Heat Seeks Balance

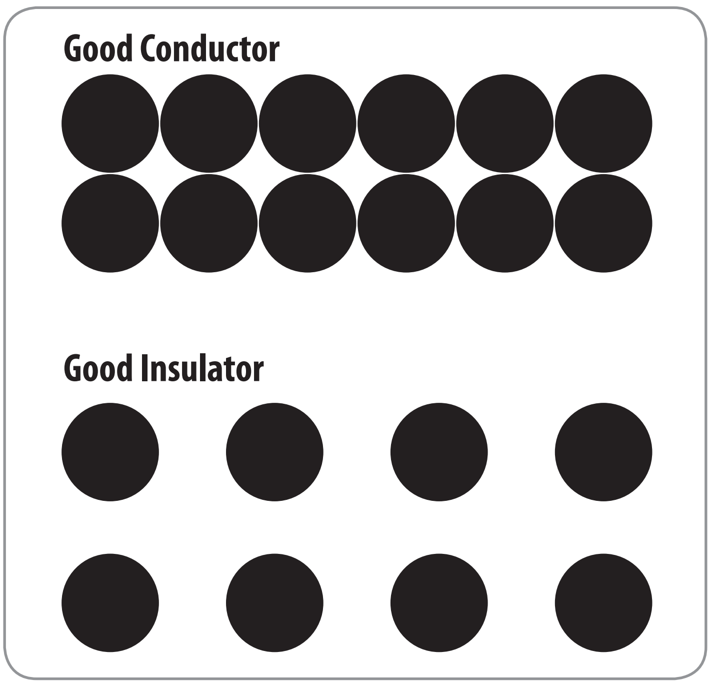
Everything in nature seeks balance. Heat seeks balance, too. Heat flows from hotter places to colder places and from hotter substances to colder substances. What happens if you pour hot water into a cold tub? The molecules of hot water have more energy. They are fast moving. They crash into the colder molecules and give them some of their energy.

Conductors and Insulators

In some materials, heat flows easily from molecule to molecule. These materials are called **conductors**. They conduct—or move—heat energy well. Materials that don't conduct heat well are called **insulators**.

The molecules in good conductors are close together. There is very little space between them. When they vibrate, they push against the molecules near them. The energy flows between them easily.

The molecules in insulators are not so close together. It is harder for energy to flow from one molecule to another in insulators.



Look at the objects to the right. The pot, the spoon, and the fork are made of metal. The pot and the fork have plastic handles. The dish is made of glass. The oven mitt is made of cotton fabric.

Which materials are the insulators? The insulators are the materials that don't move heat. They protect us from heat. Our experience tells us that wood, plastic, and cotton are all good insulators. Metals are good conductors. The metal part of the pan moves heat to the food inside to cook the food. The plastic handle protects our hands. The cotton glove protects our hands, too.

What about glass? It is not as good of a conductor or insulator as the other materials. It is used to conduct heat in pots and pans, and can also be used to insulate. Glass was once used on power and telephone lines as an insulator.

Heat and Temperature

Heat and **temperature** are different things. Two cups of boiling water would have twice as much heat as one cup of boiling water, but the water would be at the same temperature.

Temperature is a measure of the average kinetic energy of molecules. The faster the molecules move, the greater the temperature. Heat (thermal energy) is a form of energy that incorporates both the temperature (the speed of the molecules) and the amount of material, or mass of the substance. A bathtub filled with hot water will have more heat (thermal energy) than a cup of hot water at the same temperature because every drop of water has some heat and the bath tub has many more drops.

Cold things have thermal energy, or heat, even though the molecules are moving slowly and the temperature is low. A giant iceberg would have more heat (thermal energy) than a cup of boiling water, even though its temperature is lower. Each frozen particle in the iceberg has a very tiny amount of heat, but when you add them all together it becomes a significant amount of heat (thermal energy).

We Can Measure Temperature

We use thermometers to measure temperature. Thermometers can measure temperature using different scales. In the United States, we typically use the Fahrenheit (F) scale in our daily lives. Scientists typically use the Celsius (C) scale, as do people in most other countries.

Conductors and Insulators

LESSON 2: BACKGROUND INFORMATION

Heating and Cooling Systems

Heating and cooling systems use more energy than any other systems in our homes. Natural gas and electricity are used to heat most homes and electricity is used to cool almost all homes. About half of the costs for the average family's utility bills are for keeping homes at comfortable temperatures. The energy sources that power these heating and cooling systems can contribute carbon dioxide emissions to the atmosphere. Using these systems wisely can reduce environmental emissions.

With all heating and air conditioning systems, you can save energy and money too by having proper insulation, sealing air leaks, maintaining the equipment, and practicing energy-saving behaviors.

Programmable Thermostats

Programmable thermostats automatically control the temperature of buildings for time of day and can save energy and money. During heating seasons, for example, they can lower the temperature during the day when no one is home and at night when people are sleeping. In the morning and evening, when people are awake at home, they can automatically raise the temperature. Most consumers set the temperature higher than recommended during heating seasons and lower than recommended during cooling seasons. A temperature setting of 68°F (20°C) during the day and 60-62°F (13-14°C) at night during heating seasons is comfortable if people dress warmly and use warm blankets. During cooling seasons, a temperature setting of 78°F (25°C) is comfortable if people dress appropriately and use fans to circulate air. Many programmable thermostats come with pre-loaded settings. Proper use of the pre-programmed settings on a programmable thermostat can save your family about $180 every year in energy costs.

Insulation and Weatherization

Warm air leaking into your home in cooling seasons and out of your home in heating seasons wastes energy. You can reduce heating and cooling costs by investing a few hundred dollars in proper insulation and weatherization products. Insulation is rated using an R-value that indicates the resistance of the material to heat flow. The R-value needed varies, depending on the climate, ceilings, walls, attics, and floors. In very cold climates, a higher R-value is recommended.

Insulation wraps your house in a blanket, but air can still leak in or out through small cracks. Often the effect of many small leaks equals a wide open door. One of the easiest energy-saving measures is to caulk, seal, and weather-strip cracks and openings to the outside. Home performance professionals can seal air leaks in attics and basements. Homeowners typically save up to $200 a year in heating and cooling costs by air sealing their homes and adding insulation.

Doors and Windows

Some of a home's air leaks occur around and through the doors and windows. Doors should seal tightly and have door sweeps at the bottom to prevent air leaks. Insulated storm doors provide added barriers to leaking air.

Major Sources of Air Leaks

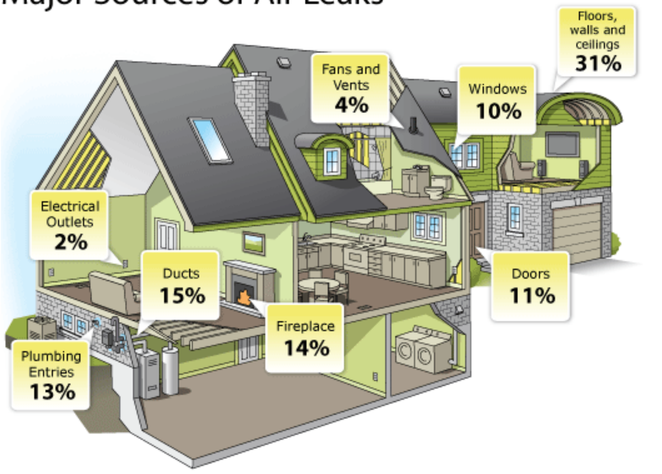
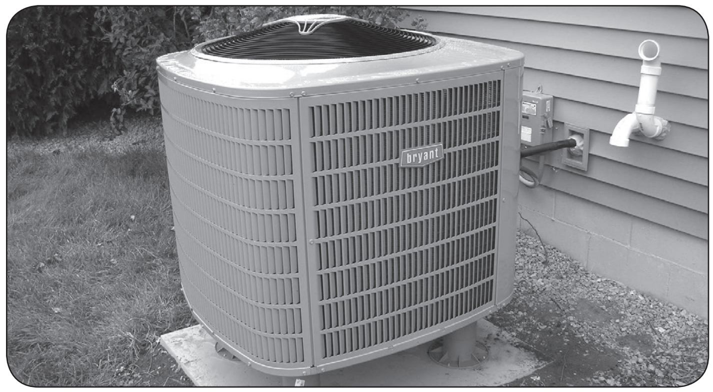
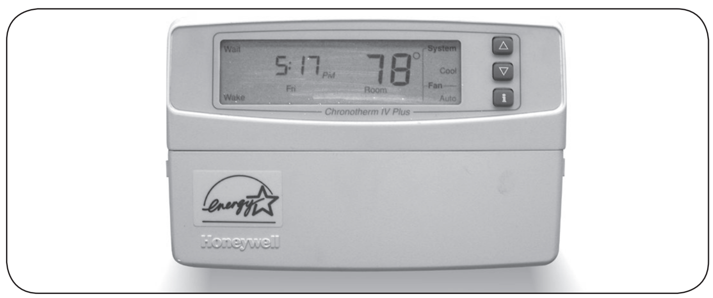


Image courtesy of InsulationSmart
Data: U.S. Department of Energy, Energy Savers

AIR CONDITIONING SYSTEM



PROGRAMMABLE THERMOSTAT



INSULATION

Image courtesy of Owens Corning

Heat Transfer

WHAT IS THE DIRECTION OF HEAT TRANSFER?

Mug of Coffee

Glass of Ice Water

House on a Summer Day

House on a Winter Day

Bathtub of Hot Water

Child in the Snow

Insulators vs. Conductors

Which of these items are conductors (transfers heat easily)?
Which of these items are insulators (reduces heat transfer)?

LESSON 2

Insulation Investigation

Question

Are certain materials better for insulating than others?

Materials

- 2 Insulation containers
- 2 Thermometers
- Insulating material
- Masking tape
- 2 Rubber bands
- Hot water (provided by teacher)

Hypothesis

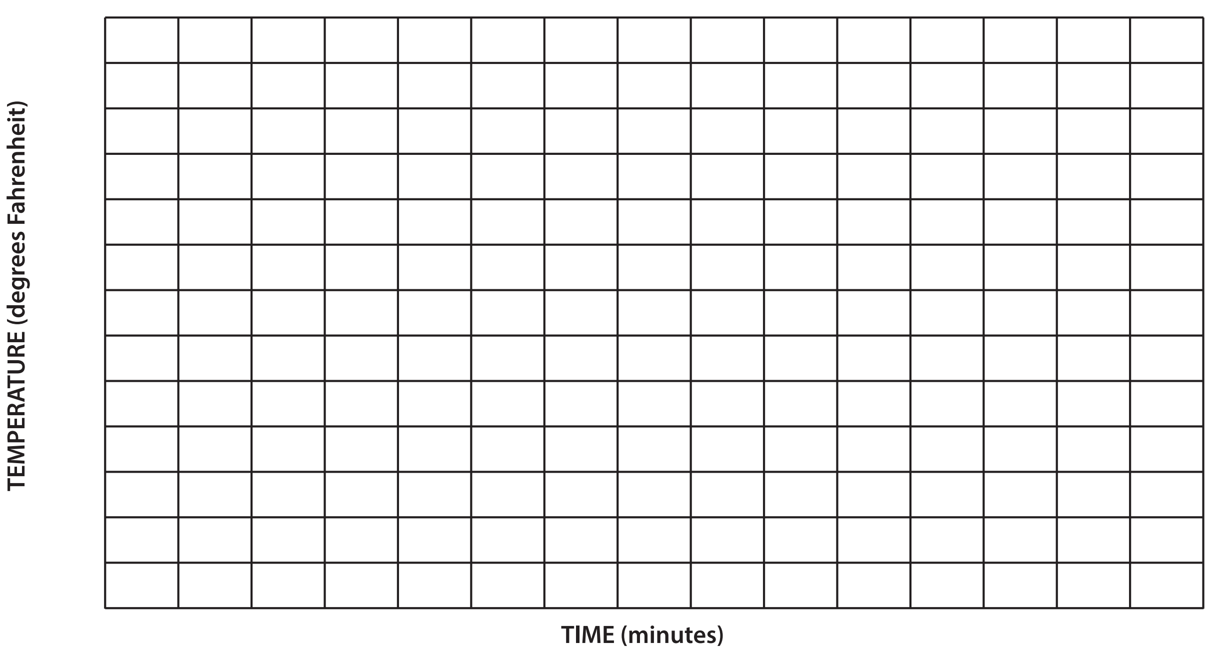
Procedure

1. Remove the tops from the cans.
2. Use the insulating material to insulate one can on the sides only. Use the rubber bands or masking tape to hold the insulation in place.
3. Ask your teacher to fill both of your cans with hot water. Replace the tops.
4. Suspend a thermometer through the hole in each top, making sure it does not touch the bottom or the sides of the can.
5. In the chart below, record the temperature (°F) of the water in the cans at one-minute intervals for 10 minutes. Your teacher will keep track of the time with a timer. Calculate the overall change in temperature (ΔT) for both cans.
6. Graph the results on the graph below.

Data Table

TYPE OF INSULATION: ____________________________________

TIME (MIN)	0	1	2	3	4	5	6	7	8	9	10	ΔT
Insulated temperature												
Uninsulated temperature												



LESSON 2

Insulation Investigation Questions

1. In 10 minutes, how much did the temperature of the water in the uninsulated container change? ***Sample = 16ºF***

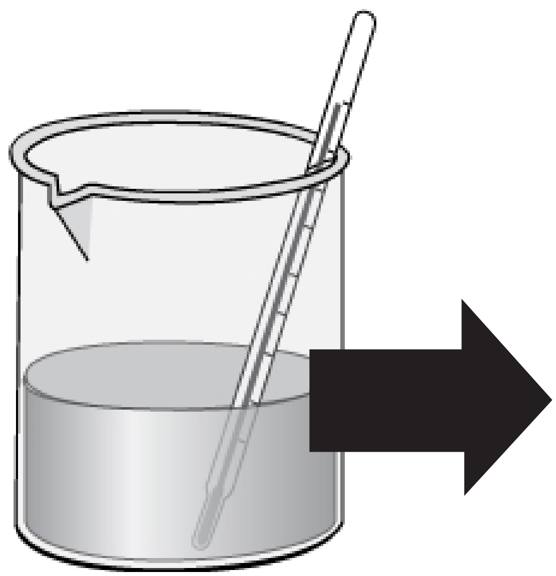
2. In 10 minutes, how much did the temperature of the water in the insulated container change? ***Sample = 11ºF***

3. After 10 minutes, what was the difference in temperature between the insulated and uninsulated container? ***Sample = 5ºF***

4. Comparing the class data, which material was the best insulator? ***Sample = bubble wrap***

5. Which material was the worst insulator? ***Sample = aluminum foil***

6. Draw arrows to show the direction of heat transfer in the experiment.



7. Heat transfers from areas of ***high*** temperature to areas of ***low*** temperature.

8. What variables in the experiment might make the results unreliable? ***Answers may include: amount of insulation, the tops and bottoms of the containers were not insulated, different people reading the thermometers, etc.***

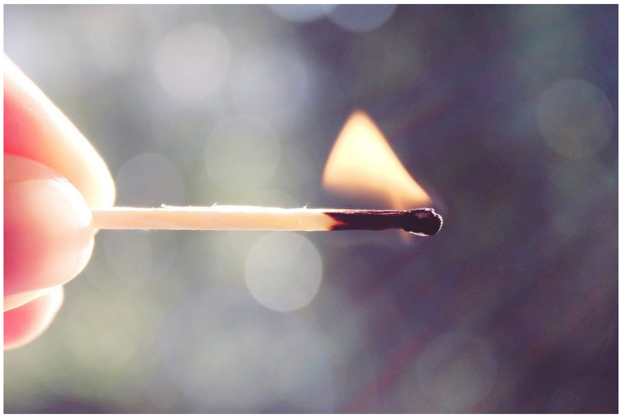
9. How might you change the experiment to get more reliable results? ***Answers may include: same amount of insulation on each container, same temperature reader, insulate tops and bottoms of containers, measure water more accurately, etc.***

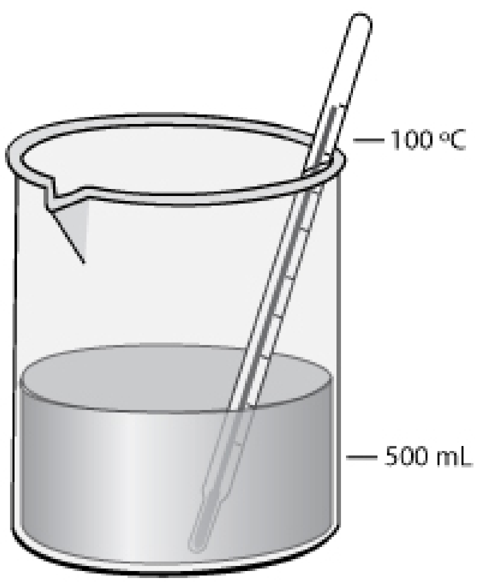
Insulation Investigation

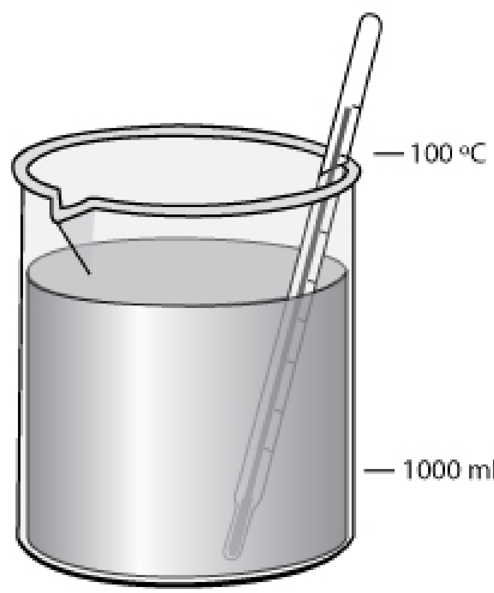
TEAM	HYPOTHESIS: RANK THE MATERIALS 1 TO 5. 1 IS THE BEST INSULATOR.	UNINSULATED ΔT	INSULATED ΔT
1. Material: ____________			
2. Material: ____________			
3. Material: ____________			
4. Material: ____________			
5. Material: ____________			

Heat vs. Temperature

Which has more heat energy?







LESSON 2

Temperature Investigation

Questions

- Which rooms in the school will have the highest and lowest temperature?
- Which room in the school will have the most heat?

Materials

- Digital thermometer or LCD thermometer

Hypothesis

____

✔ Procedure

1. Find out the answers to the following questions:

   Which system is in operation (heating or cooling)? ______________________________

   What energy source fuels the heating system? ______________________________

   What energy source fuels the cooling system? ______________________________

2. Locate the thermostat in the classroom. Record the temperature setting of the thermostat. ____________________
3. Using the thermometer, record the actual temperature of the classroom. ____________________
4. Using the *Thermostat Temperature Guide* at the bottom of the page, determine whether your classroom is saving or wasting energy and by how much. ____
5. Visit other rooms in the school and record the temperature, thermostat setting, and percent of energy saved or wasted in the chart below.

Room	Thermostat Setting (°F)	Actual Temperature (°F)	Energy Saving/Wasting Percentage

6. Which room in the school had the highest temperature? ____________ The lowest temperature? ____________
   The most heat (thermal energy)? ____________
7. Is your school saving or wasting energy today with heating and cooling? ____________

Thermostat Temperature Guide *IN FAHRENHEIT*

RECOMMENDED HEATING

ENERGY SAVING | *ENERGY WASTING*

-20%	-10%	0%	+10%	+20%	+30%	+40%	+50%	+ + + + + + + + +
64°	**66°**	**68°**	**70°**	**72°**	**74°**	**76°**	**78°**	**80°**	**82°**
✚ ✚ ✚ ✚ ✚ ✚ ✚ ✚ ✚ ✚ ✚ ✚ ✚ ✚				+30%	+20%	+10%	0	-10%	-20%

ENERGY WASTING | *ENERGY SAVING*

RECOMMENDED COOLING

Temperature Guide

RECOMMENDED HEATING

ENERGY SAVING | *ENERGY WASTING*

-20%	-10%	0%	+10%	+20%	+30%	+40%	+50%	+ + + + + + + + +	
64^0	66^0	68^0	70^0	72^0	74^0	76^0	78^0	80^0	82^0
+ + + + + + + + + + + + + +				+30%	+20%	+10%	0	-10%	-20%

ENERGY WASTING | *ENERGY SAVING*

RECOMMENDED COOLING

Room	Thermostat Setting (°F)	Actual Temperature (°F)	Energy Saving/Wasting Percentage

LESSON 2

Home Activity

Investigating Home Insulation and Thermostats

Materials

- Weather stripping
- Door sweep and draft stoppers (if available)
- *Thermostat Temperature Guide* on page 27

✔ Procedure

1. Open your outside doors and check the condition of the weather stripping between the doors and the door frame.

   ______ poor ________ fair ________ good

2. Using the graphic in the Lesson 2 Background Information, "Major Sources of Air Leaks," decide with your family the five areas of your home you will check for air leaks.

   I. ____________________________ IV. ____________________________

   II. ____________________________ V.____________________________

   III. ____________________________

3. Using the graphic below, "How Air Escapes," circle the top three ways air can escape from your home.

4. Locate the thermostat(s) in your home. With the help of an adult, record the thermostat settings for your home:

   Heating Season __________________

   Cooling Season __________________

5. Using the *Thermostat Temperature Guide* on page 27, calculate the percent of energy saved or wasted at this temperature setting.

   ____________ % energy saved OR ____________ % energy wasted

6. Decide with your family two ways you can save energy on heating and cooling.

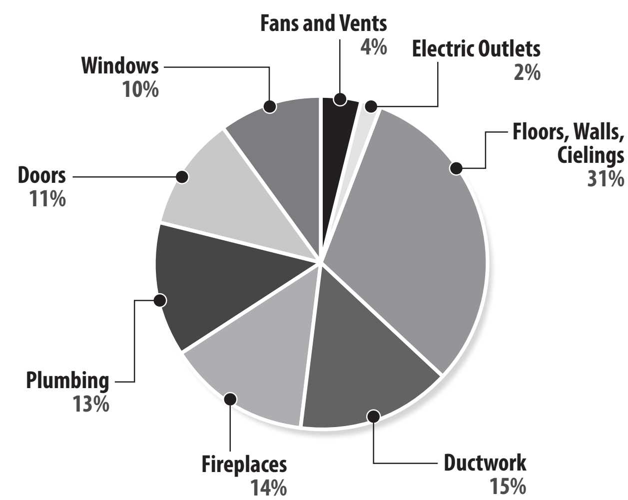
   I. ________________________________

   II. ________________________________

Actions

1. With an adult, install the weather stripping (and door sweep and draft stoppers if available).
2. Discuss changing the thermostat to the recommended settings of 68ºF in the winter and 78ºF in the summer.

How Air Escapes



Data: DOE, Energy Savers Guide

LESSON 2 - Insulation, Heating, and Cooling

ASSESSMENT

1. Draw an arrow to show how heat will transfer for the following items:

Mug of Coffee

House on a Summer Day

2. Weather stripping reduces the transfer of heat and works as a thermal ___________.

   a. conductor   **b. insulator**   c. contact   d. covering

3. A material that increases heat transfer (such as a metal pan) is a thermal ___________.

   a. conductor   b. wave   c. insulator   d. coat

4. Which item would have a higher temperature?

   a. small flame from a match   c. jug of water

   b. glacier   d. car

5. Which item would have more thermal or heat energy?

   a. small flame from a match   c. jug of water

   b. glacier   d. car

6. Explain why insulation is important in your home.

   Insulation reduces the transfer of heat to and from the house, saving energy and money from heating and cooling the home.

7. Explain where the heat travels when you leave the refrigerator door open.

   Heat always travels from hot to cold, or areas of higher temperature to areas of lower temperature, so heat would travel from the warmer kitchen air into the cooler refrigerator.

Connections *(pg 30, Student and Family Guide)*

1. List two animals and discuss how they use "natural" insulation to maintain body temperature.
2. What are some ways you can be comfortable in your home without adjusting the temperature and using more energy?
3. List and explain two ways your family could save energy when heating and cooling your home home.

Lesson 3: Water Heating

Overview

This lesson focuses on heating water and using hot water, the second largest energy cost in most homes.

Objectives

- Students will be able to measure temperature accurately using appropriate tools and converting units when necessary.
- Students will be able to list and describe methods for conserving water.
- Students will be able to explain a water heater's role in home energy savings.
- Students will be able to explain and calculate the energy cost for appliances or major purchases.

Materials

- Digital thermometer
- Flow meter bag
- Hot water gauge (from Student Sample Efficiency Kit)
- Natural gas scratch and sniff (if available from Student Efficiency Kit)
- Natural Gas Sequence
- Safety Sort

Masters

- *EnergyGuide Label (3-1)*

Student and Family Guide

- *Background Information*
- *Water Heating Investigation*
- *Comparing EnergyGuide Labels*
- *Home Activity*
- *Assessment*
- *Connections*

Home Energy Efficiency Kit Materials

- Hot water gauge
- Flow meter bag
- Kitchen sink aerator, bathroom sink aerator, low flow showerhead, teflon tape, natural gas scratch and sniff (if available)

Preparation

- Prior to the lesson, arrange to have someone from the maintenance or facilities staff show the students the water heating system(s) and answer questions about the energy sources that fuel the components.
- Review instructions for the hot water gauge and flow meter bag. Instructions are printed on the bag and gauge.

Safety Note

The flow meter bag should only be used to measure cold water. Warn the students not to touch the hot water.

✔ Procedure

1. Introduce the lesson by discussing how we heat water at school and home. Review the Lesson 3 Background Information.
2. List ways hot water is used in schools and homes.
3. List ways to cut water-heating bills—use less hot water, turn down the water heater thermostat, insulate the water heater, use an energy efficient water heater. Emphasize ways to use less hot water—taking short showers instead of baths, running the dishwasher only when it is full, washing clothes in cold water, filling the sink when hand-washing dishes instead of washing under running water, etc.
4. Display the *EnergyGuide Label (3-1)* master and explain the information it includes.
5. Inspect the school's water heating system with someone from the maintenance or facilities staff, locating the EnergyGuide label and the thermostat.

6. Ask the maintenance person the following questions: At what temperature is the thermostat set? What energy source is used to fuel the water heating system?
7. Instruct the students to enter the information in the appropriate blanks on the *Water Heating Investigation* in the Student and Family Guide.
8. Review the procedure for the rest of the investigation.
9. Instruct the students in the correct operation of the hot water gauge and flow meter bag.
10. Distribute one hot water gauge, one digital thermometer, and one flow meter bag to each team.
11. Instruct the students to complete the investigation.
12. Review each team's data so that all students can record the data in their charts.
13. Compare recorded water temperatures with recommended temperatures.
14. Discuss whether any changes should be recommended based on the results of the discussion.
15. Explain that many hot water heaters use natural gas. Natural gas is colorless and odorless so a chemical called mercaptan is added to the natural gas so that natural gas can be detected. Distribute the natural gas scratch and sniff cards from the Student Energy Efficiency Kits (if available). Ask students to sniff the cards and to tell an adult and leave their home immediately if they ever recognize that smell at home.
16. Complete the *Comparing EnergyGuide Labels* activity in the *Student and Family Guide*. Display the answer key if needed.
17. Optional: Complete the *Natural Gas Sequence* to follow the production and transformation of natural gas for heating. Materials and instructions are located in the Classroom Kit.
18. Optional: Complete *Safety Sort*. Use a Venn diagram to explore safety with electricty and natural gas. Materials and instructions are located in the Classroom Kit.

✔ Home Action Item and Wrap Up

1. Review the *Home Activity* in the *Student and Family Guide* with the students and assign a completion date.
2. Give each student their hot water guage and flow meter bag. If available give students their kitchen sink aerator, bathroom sink aerator, low flow showerhead, Teflon tape and natural gas scratch and sniff card.
3. Have students complete the *Assessment* and *Connections* activities in the *Student and Family Guide*.

LESSON 3

Background Information: Water Heating

Water heating is the second largest energy expense in homes. It typically accounts for about 18 percent of the average utility bill. Heated water is used for showers, baths, laundry, dish washing, and cleaning. The greatest cost of washing dishes, bathing, and washing clothes comes from the energy required to heat the water. There are four main ways you can lower your water heating bills:

- use less hot water;
- turn down the thermostat on your water heater;
- insulate your water heater and water pipes; and
- buy an ENERGY STAR® or energy efficient water heater, dishwasher, and washing machine.

The easiest way to cut the cost of heating water is to reduce the amount of hot water you use. This can be done with little cost and minor changes in lifestyle. For example, a five minute shower uses 10-25 gallons of water. You can cut that amount in half by using a low-flow shower head.

Other ways to conserve hot water include taking showers instead of baths, taking shorter showers, fixing leaks in faucets and pipes, and using the lowest temperature wash and rinse settings on clothes washers.

Most water heater thermostats are set much higher than necessary. Lowering the temperature setting on your water heater to 120°F (49°C) saves energy. Lowering the temperature 10 degrees Fahrenheit (6°C) can result in energy savings of $12-$30 annually. Buying a high efficiency water heater can save $40-$140 a year.

EnergyGuide Labels

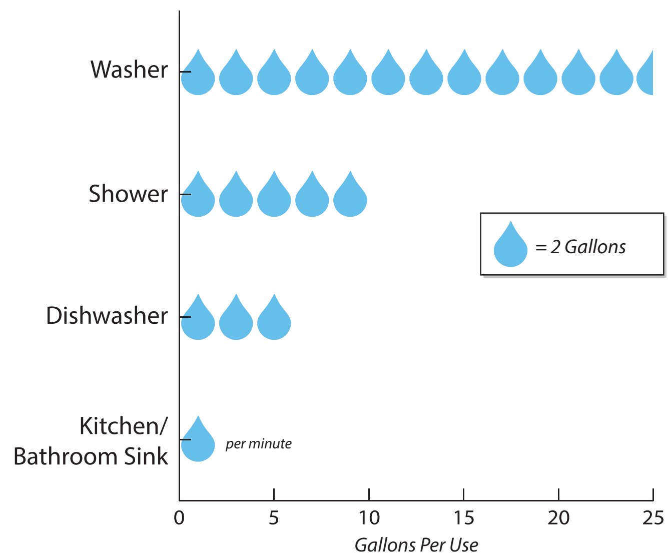
Another way to determine which appliance is more energy efficient is to compare energy usage using **EnergyGuide labels**. The government requires most appliances to display bright yellow and black EnergyGuide labels. Although these labels do not tell you which appliance is the most efficient, they will tell you the annual energy consumption and operating cost of each appliance so you can compare them.

Natural Gas Safety

Because natural gas is colorless, odorless and tasteless, a chemical called mercaptan is added to the gas before distribution. Mercaptan gives it a "rotten eggs" smell so that people can detect natural gas leaks.

Before your family begins any digging project be sure to call 811. Local utility companies will mark the utility lines in your yard within 2-3 days of your call so that you can dig safely.

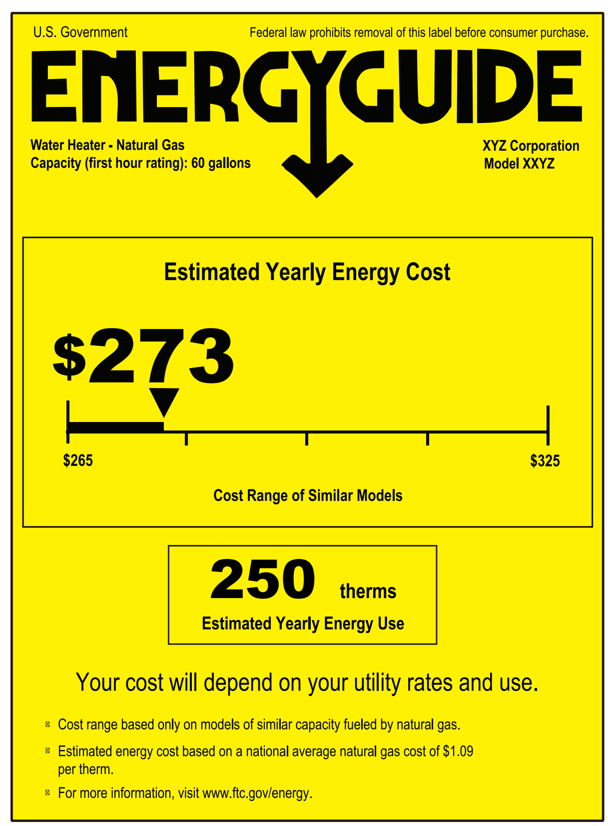
Water Consumption of Common Devices



Data: DOE, Energy Savers Guide

When appliances and faucets use hot water, you pay for the water and the utility costs to heat the water. Save hot water whenever possible.

ENERGYGUIDE LABEL



U.S. Government

Federal law prohibits removal of this label before consumer purchase.

ENERGYGUIDE

Water Heater - Natural Gas
Capacity (first hour rating): 60 gallons

XYZ Corporation
Model XXYZ

Estimated Yearly Energy Cost

$273

$265 **$325**

Cost Range of Similar Models

250 **therms**

Estimated Yearly Energy Use

Your cost will depend on your utility rates and use.

- Cost range based only on models of similar capacity fueled by natural gas.
- Estimated energy cost based on a national average natural gas cost of $1.09 per therm.
- For more information, visit www.ftc.gov/energy.

LESSON 3

Water Heating Investigation

Question

Is water temperature constant throughout the school and is it set correctly?

Materials

- 1 Flow meter bag
- 1 Hot water gauge
- Digital thermometer

Hypothesis

____

____

Procedure

1. What energy source fuels the water heating system? ________________________
2. Record the temperature setting of the hot water thermostat. ____________________

With the help of an adult:

3. Identify water sources in your school and list them below.
   - With the flow meter bag, measure the water flow of all sources and record on the chart below. **FOR YOUR SAFETY: Measure ONLY COLD water with the flow meter bag.**
   - With the hot water gauge or digital thermometer, measure the temperature of the hot water at all sources and record on the chart. **FOR YOUR SAFETY: BE CAREFUL not to touch the water.**
4. Compare the actual temperature to the recommended temperature of 120°F.
5. Gather data from the other teams and add below.

LOCATION	WATER FLOW	ACTUAL TEMPERATURE	>, <, OR = TO RECOMMENDED TEMPERATURE OF 120°F

Comparing EnergyGuide Labels Answer Key

Comparing EnergyGuide Labels

Your family needs to buy a new water heater. Water heaters usually last a long time—10 years or more—so you can save a lot of money using an energy-efficient one. Use the chart below to figure out which water heater to buy, comparing the information on the EnergyGuide labels.

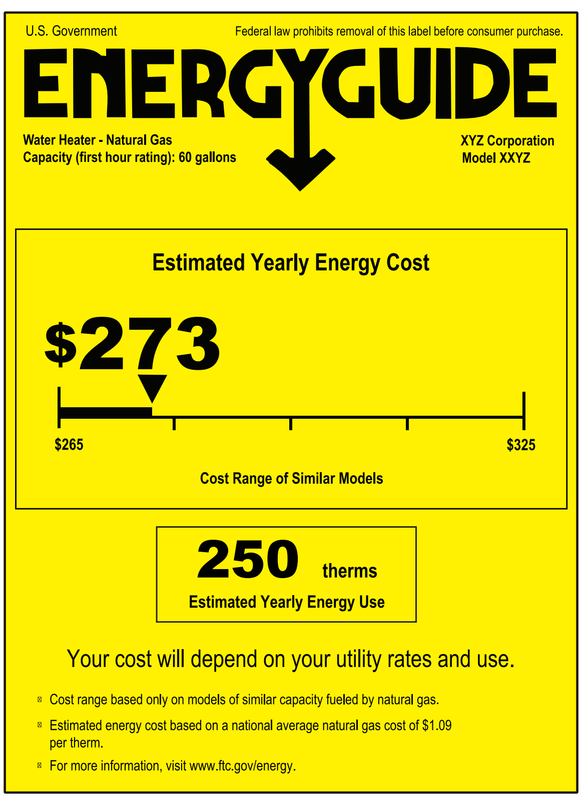
How many years will it take before you begin to save money? ***Four years***

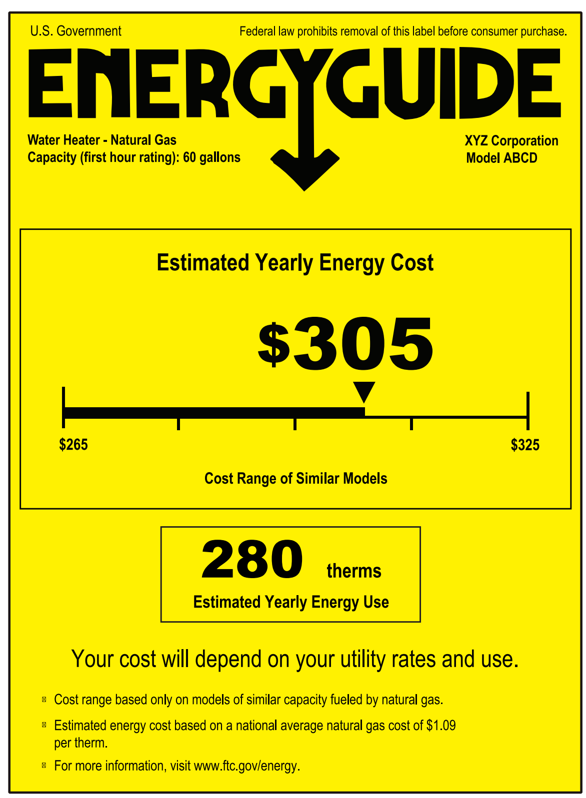
How much money will you have saved after seven years? ***$99.00***

Water Heater 1—Purchase Price: $375.00

Water Heater 2— Purchase Price: $250.00

WATER HEATER 1	EXPENSES	COST TO DATE	WATER HEATER 2	EXPENSES	COST TO DATE
Purchase Price	$375	$375	**Purchase Price**	$250	$250
Year One	$273	$648	**Year One**	$305	$555
Year Two	$273	$921	**Year Two**	$305	$860
Year Three	$273	$1,194	**Year Three**	$305	$1,165
Year Four	$273	$1,467	**Year Four**	$305	$1,470
Year Five	$273	$1,740	**Year Five**	$305	$1,775
Year Six	$273	$2,013	**Year Six**	$305	$2,080
Year Seven	$273	$2,286	**Year Seven**	$305	$2,385





LESSON 3

Home Activity

Investigating Home Water Heating and Usage

Materials

- Hot water gauge
- Flow meter bag
- Kitchen sink aerator (if available)
- Bathroom sink aerator (if available)
- Low flow showerhead (if available)
- Teflon tape (if available)
- Natural gas scratch n' sniff card (if available)

✔ Procedure

With the help of an adult:

1. Locate the water heater. Read and record the temperature setting of the water heater. ___________________
2. Locate the EnergyGuide label and record the estimated yearly energy cost. __________________
3. Use the hot water gauge to measure the temperature of the hot water in your bathroom sink. Is the temp greater than 120ºF? __________
4. Use the flow meter bag to measure how much COLD water your main shower uses. If the showerhead is NOT efficient based on the chart on the bag, install the low flow showerhead, if available. Measure again.
5. Use the flow meter bag to measure how much COLD water your main bathroom sink and kitchen sink use. If they are NOT efficient based on the chart on the bag, install the energy efficient aerators, if available. Measure again.

WATER FLOW	BEFORE INSTALLATION	AFTER INSTALLATION
Main Shower		
Main Bathroom Sink		
Kitchen Sink		

6. Share the natural gas scratch n' sniff card (if available) with family members to ensure everyone can recognize the smell of a gas leak.
7. Visit your local utility's website (listed on the front cover) to find out about other residential energy saving programs including rebates and online audits.

The Tools

Hot Water Gauge: Measures the temperature of your hot water. See instructions on plastic card.

Flow Meter Bag: Measures the amount of water flow. Instructions are on the bag.

Aerators and Showerheads: Reduce the water flow without reducing pressure. The smaller aerator is for the main bathroom sink; the larger aerator is for the kitchen sink. Install using instructions for the showerhead.

Teflon Tape: Ensures a tight seal for showerhead and aerators.

LESSON 3 – Water Heating

ASSESSMENT

1. The second largest energy expense in your home is __________.

   a. lighting **b. heating water** c. heating/cooling d. refrigeration

2. For maximum energy efficiency, the ideal temperature for a water heater is __________.

   a. 100^{0} F b. 200^{0} F **c. 120^{0} F** d. 180^{0} F

3. A device used on a faucet that maintains pressure while conserving water is __________.

   a. an aerator b. a water heater c. a flow meter bag d. a filter

4. Which of the following is not a possible energy source for a water heater? __________.

   a. natural gas b. electricity c. propane **d. wind**

5. Identify two ways you can save energy while taking a shower.

   Possible answers include: Take shorter showers, use a low-flow showerhead, use water at a slightly lower temperature, turn water off to lather and scrub and turn water back on to rinse

6. Describe a flow meter bag and how it is used. When measuring water flow rate, what units are used to describe it. Identify an efficient flow rate for a showerhead.

   The flow meter bag was the clear plastic bag with blue markings in the Home Energy Efficiency Kit. It is used by placing it under the faucet or showerhead and turning the water on full for five seconds. The next step is to hold the bag of water up and read the measurement. Flow rate is measured and reported in Gallons per Minute or GPM and an efficient showerhead flows at 2.5 GPM. The showerhead in the kit uses only 1.25 GPM which saves even more energy and water.

Connections *(pg 36, Student and Family Guide)*

1. What did you learn using the hot water gauge and the flow meter bag?
2. Describe 3 ways your family will reduce your hot water use.
3. Explain how buying an energy efficient appliance can save money, even if it costs more to buy.

Lesson 4 - Lighting Investigation

Overview

This lesson focuses on energy efficient lighting. Students will compare the heat produced and energy used by different types of bulbs.

Objectives

- Students will be able to compare and contrast the efficiency of different types of light bulbs.
- Student will be able to calculate life cycle costs and interpret savings based on calculations.
- Students will be able to show how lighting affects their energy usage and that changing the type of light bulb impacts energy costs.

Materials

- Light Emitting Diode (LED) bulb (from Sample Student Efficiency Kit)
- Incandescent (IL) bulb
- Compact Fluorescent (CFL) bulb (from Sample Student Efficiency Kit)
- Lamps (3)
- Thermometers (3)
- *Watt About the Bulb Activity*

Student and Family Guide

- *Background Information*
- *Lighting Investigation*
- *Light Bulb Comparison*
- *Facts of Light*
- *Facts of Light Summary*
- *Home Activity*
- *Assessment*
- *Connections*

Home Energy Efficiency Kit Materials

- CFL bulb
- LED Nightlight (if available)
- LED bulb (if available)

Preparation

- Prior to the lesson assemble and set up the lamps with the various bulbs.

Procedure

Light Bulb Investigation

1. Introduce the topic of lighting and the three types of light bulbs by reviewing the background information presented on lighting in the Student and Family Guide. Review lighting at school and at home and discuss the differences in lighting in both environments.
2. Hold up or display the three different bulbs to show the difference visually.
3. Review the *Light Bulb Comparison* in the *Student and Family Guide*. Discuss the following key vocabulary with the students:
    - Lumens - a measure of the amount of light falling on an object at a given distance, often referred to as "brightness."
    - Watts - units of power, the rate at which a bulb or appliance uses energy.
    - Kilowatt – 1,000 watts. It is more useful when talking about electricity use than a single watt because we use so many thousands of watts.
    - Kilowatt-hour - the unit in which we buy electricity. It is a unit for energy. It is equal to 1,000 watts used for one hour. Kilowatt-hours are calculated by multiplying kilowatts times hours used.

4. Review the Lighting Investigation procedure in the *Student and Family Guide*.
5. Demonstrate how to read the thermometer. For safest data collection, mount the thermometer on a stand or lay the thermometer on a table under the lamp bases, so the students do not have to hold the thermometers. Remind students to keep thermometers the same distance from each bulb.
6. Assign roles to the students. There should be three thermometer readers, a timer and a data recorder.
7. Instruct students to record the initial temperature and then record the temperature every minute for 10 minutes on the data table. After 10 minutes, calculate the change in temperature for all three bulbs.
8. Have students graph the results of the investigation on the graph paper using different colors for each bulb.
9. Discuss why the incandescent bulb gets so much hotter. Explain how the electricity flows through a thin tungsten wire called a filament and actually gets so hot it emits light and glows. This bulb was invented by Thomas Edison in 1879.
10. Explain that compact fluorescent bulbs do not have a filament. CFLs are actually a tube of gas. When electricity flows through the gas from a magnetic or electronic ballast, the gas emits ultraviolet light. That ultraviolet (UV) light strikes a painted white phosphor coating on the inside of the tube. Phosphor is a substance that can emit visible light when it is struck by UV light. The coating of the tube is what glows.
11. Describe that the LED bulb contains semiconductors like solar panels. There are three layers within the LED that combine to produce light. Voltage is needed to energize the electrons so they move back and forth between the layers and emit light.
12. Ask students to list the variables and controls in this experiment. Variable means 'can change'.
    - The **independent** variable is the one you are investigating. It is the one which you deliberately change in the experiment. You should only have one independent variable. In our investigation, the bulb is the independent variable.
    - The **dependent** variable is the variable which you measure to get your results. Often there is only a single dependent variable but there can be more. The dependent variable in our investigation is temperature, which we measure over 10 minutes.
    - All other variables must be **controlled** or kept constant so they do not change the result. There are usually many controlled variables in an experiment. Those include distance, thermometers, bases, time interval, location, and lumens.

Facts of Light

1. Review the *Light Bulb Comparison* in the *Student and Family Guide* and explain that students will compare the costs of purchasing and operating the three types of bulbs.
2. Review the following terms as needed: lumens, watts, kilowatt, kilowatt-hour, life cycle cost.
3. If possible, distribute real light bulb packaging or copies, and have students complete the *Facts of Light Worksheet* using data from the *Light Bulb Comparison*. If possible, display *Light Bulb Comparison*.
4. Help students work through the calculations and then review the data, calculations and questions. Have students transfer data to the *Facts of Light Summary* to review with their parents.
5. Optional: Complete *Watt About the Bulb* activity using instructions and cards in the Classroon Kit. Students compare the three bulbs using a Venn Diagram.

✔ Home Action Item and Wrap Up

1. Review the *Home Activity* in the *Student and Family Guide* with the students and assign a completion date.
2. Give each student their CFL bulb. If available distribute the LED bulbs and LED nightlight.
3. Have students complete the *Assessment* and *Connections* activities in the *Student and Family Guide.*

Background Information: Lighting

In 2012, legislation under the Energy Independence and Security Act put restrictions on how much energy light bulbs use. Traditional bulbs, called **incandescent** bulbs, have been replaced by more efficient bulbs like **halogens**, **compact fluorescents**, and **light emitting diodes** (LEDs) on store shelves.

Lighting accounts for five percent of a home's energy use, which translates to about 14% of the home's electricity bill. Much of this is the result of using inefficient lighting. Many homes still use incandescent lighting. Only 10 percent of the energy consumed by an incandescent bulb actually produces light; the rest is given off as heat. There are other more efficient lighting choices on the market, including halogens, fluorescents, and LEDs. Halogens are sometimes called energy-saving incandescent bulbs because they last slightly longer, and use less energy than traditional incandescent bulbs, however they can burn hotter than incandescent lights do. Fluorescent lights produce very little heat and are even more efficient. Most schools use fluorescent tube lighting throughout the building, but may use incandescent bulbs in other spaces around the school.

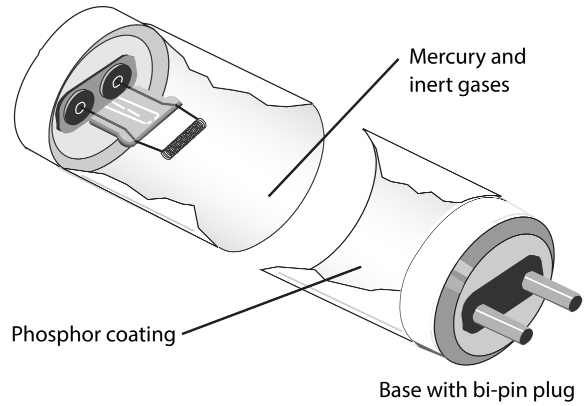
A fluorescent lamp is a glass tube lined inside with a phosphor coating. The tube is filled with argon gas and a small amount of mercury. At the ends of the tube are electrodes that generate an electric field when electricity flows through them. The energized electrons cause the mercury gas to emit UV (ultra violet) light. The invisible UV light strikes the phosphor coating, which emits visible light.

Incandescent bulbs have a tungsten filament inside the bulb. An electric current passes through the filament, heating it until it glows. Almost 90% of the energy in the bulb is given off as heat.

Recycle Used CFLs

CFL bulbs contain mercury inside their glass tubing. While it is only a small amount, CFL bulbs should be recycled to make sure mercury is disposed of properly. Check local retailers or municipalities for recycling programs.

Fluorescent Tube Lamp



In fluorescent tubes, a very small amount of mercury mixes with inert gases to conduct the electric current. This allows the phosphor coating on the glass tube to emit light.

Compact Fluorescent Light Bulbs

CFLs come in a variety of styles for different purposes. CFLs use about one-third the energy of a halogen incandescent.

LESSON 4: BACKGROUND INFORMATION

LEDs have been commonly found in electronic devices and exit signs. Now they are offered as affordable options for lighting in homes and businesses. Light emitting diodes contain **semiconductors** like solar panels; the difference is in the way the electrical energy is used by the LED. Three layers within the LED – p-type, n-type, and a depletion zone – combine to produce light. A minimum voltage is needed to energize electrons and they move from one layer to the next. When the electrons move back again, they emit light that we see.

One of the quickest and easiest ways to immediately decrease your electricity bill is to install CFL or LED bulbs in the place of incandescent or halogen bulbs. For every 100-watt incandescent bulb replaced, a savings of $30-$80 can be realized over the lifetime of the bulb. A CFL uses 75 percent less energy than an incandescent, and an LED bulb uses even less energy. CFL and LED bulbs last longer than incandescent bulbs, too. Each type of bulb has benefits as well as drawbacks. For example, a CFL is less expensive than an LED, but it is more fragile, contains mercury, and is not always dimmable. An LED is more durable than a CFL, but it is heavier and is sometimes more expensive. Both types are available in a wide variety of shapes and light colors. When shopping for a replacement bulb, look for ENERGY STAR® rated bulbs for the best quality and energy efficiency ratings, and make sure the bulb you buy produces the same brightness of light, as measured in lumens.

There are a few ways you can save energy on lighting in the home:

- switch incandescent bulbs to CFLs or LEDs;
- shut off lighting when exiting the room; and
- use natural light by opening blinds or curtains when possible.

Facts of Light

Lights bulbs can be compared in a variety of ways. When looking at different light bulbs you must consider:

- Lumens: the amount of light the bulb produces
- Watts: the amount of electricity the bulb uses
- Life: how many hours the bulb should last

Did You Know?

Only 10 percent of the energy used by a traditional incandescent bulb produces light. The rest is given off as heat.

INCANDESCENT BULB

HALOGEN BULB

CFL BULB

LED BULB

LEDs offer better light quality than incandescent bulbs and halogens, last 25 times as long, and use even less energy than CFLs. LEDs now have a wide array of uses because technology has improved and costs have decreased. It is possible to see CFL use decrease as LED costs continue to improve.

LESSON 4

Lighting Investigation

Question

How much heat (thermal energy) does an incandescent light bulb (IL) produce compared to a CFL and LED bulb?

Materials

- 3 lamp bases
- 1 Incandescent bulb (IL)
- 1 Fluorescent bulb (CFL)
- 1 Light emitting diode bulb (LED)
- 3 Digital thermometers

Hypothesis

____

____

✔ Procedure

1. Record student roles for each member in the group:

    a. CFL Thermometer reader________________________

    b. IL Thermometer reader ________________________

    c. LED Thermometer reader ________________________

    d. Timer ________________________

    e. Data Recorder ________________________

2. Set up all three light bulbs in their lamp bases and plug each into an outlet.

3. Place the digital thermometers 5-10 cm from each bulb. Be sure to keep everything the same for all three bulbs. Taping the thermometers down works well.

4. Take the initial temperature of all three thermometers before turning on the bulbs and record on the data sheet. ***Safety note: Do NOT touch the IL bulb as it gets very HOT quickly.*** Turn all 3 bulbs on at the same time and begin recording the temperature every minute for 10 minutes.

5. After 10 minutes, calculate the change in temperature for each bulb and record.

6. Graph the results of your temperature investigation. Use a different color for each of the bulbs. Make a key showing which bulb each color represents. Label the graph and give it a title.

7. With your group, answer the questions regarding the results of your temperature investigation.

LESSON 4

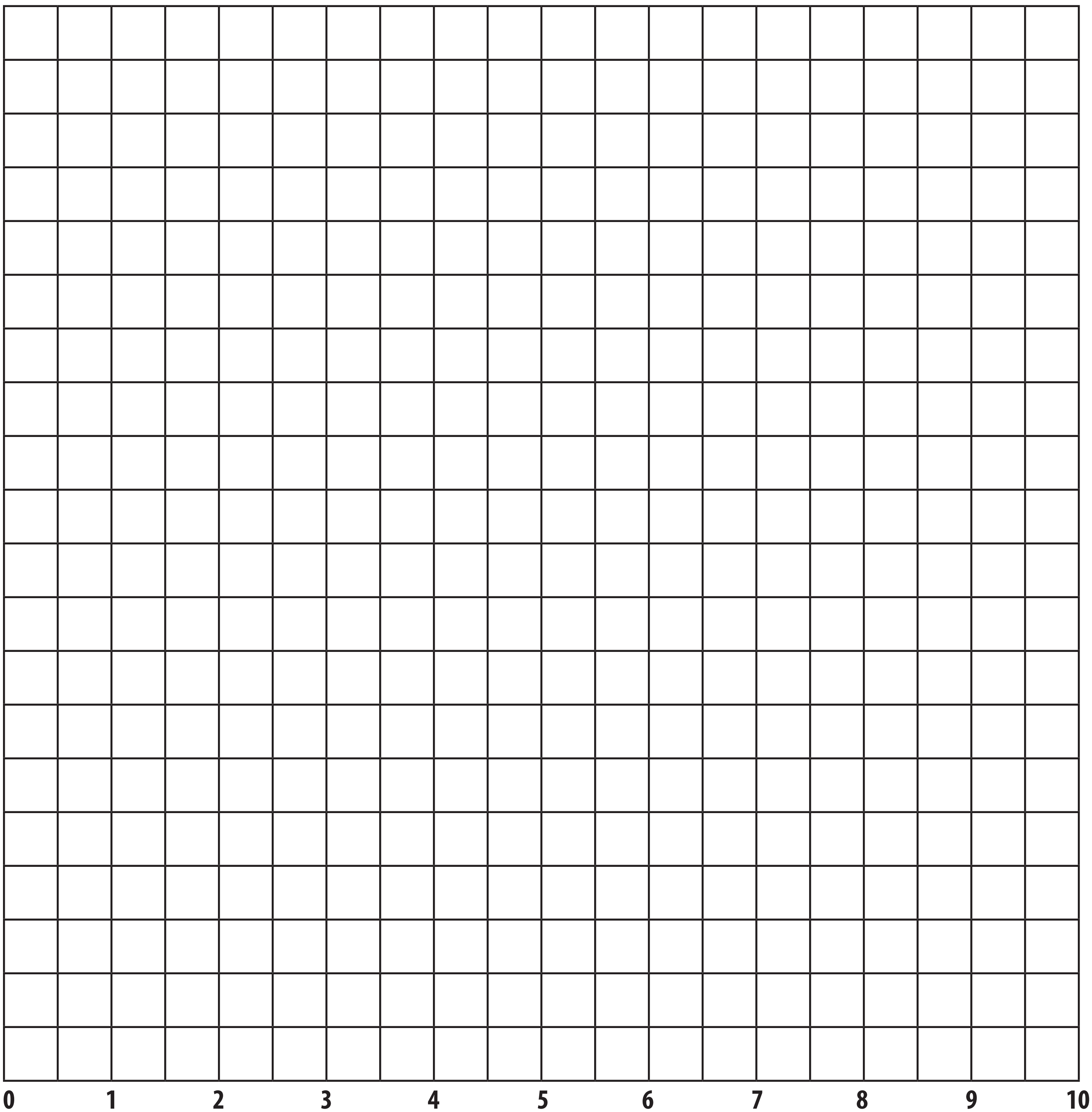
Lighting Investigation

DATA SHEET

Time (min)	Temperature of CFL Bulb (°C)	Temperature of IL Bulb (°C)	Temperature of LED Bulb (°C)
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
Change in Temperature ΔT			

Lighting Investigation

GRAPH TITLE____



COLOR KEY: ☐ **CFL** ☐ **LED** ☐ **IL**

Lighting Investigation Results: Answer Key

1. Do your results support your hypothesis? Explain.

   Responses will vary. Discuss a variety of different ideas from students. Have students show their results on their graphs which will show the biggest increase in temperature for the IL, then the CFL, and lowest will be the LED.

2. What characteristics do the light bulbs have in common?

   They all produce light and heat. They each have a metal base.

3. How do the light bulbs differ?

   They are different shapes and sizes and have different light qualities. LEDs are better in colder temperatures. CFLs have a special disposal method. Some produce less heat than others. The IL can burn your skin badly if touched, but the other two can be touched.

4. Which light bulb is coolest in temperature when in use?

   The LED is the coolest.

5. Which bulb is truly a "heat bulb", not a "light bulb"? Explain your answer.

   The incandescent bulb is truly a heat bulb, because only 10 percent of energy is transformed into light and 90% into heat or thermal energy.

6. What variables remain controlled?

   Variables that were controlled (kept constant) in this investigation were distance of thermometer to the bulb, and using the same type of thermometer and lamp. The time intervals and location were kept the same. The lumens is the same for all three bulbs.

7. What was your independent variable?

   The independent variable is the bulb, which was purposely changed.

8. What is the dependent variable?

   The dependent variable is temperature, which we are measuring to show the results of the investigation.

Light Bulb Comparison

	INCANDESCENT BULB (IL)	COMPACT FLUORESCENT (CFL)	LIGHT EMITTING DIODE (LED)
Brightness	850 lumens	850 lumens	850 lumens
Life of Bulb	1,000 hours	12,500 hours	25,000 hours
Energy Used	60 watts = 0.06 kW	13 watts = 0.013 kW	12 watts = 0.012 kW
Price per Bulb	$0.50	$3.00	$5.00

Facts of Light

Why should I change my light bulbs? That is a great question! To get the answer, we need to look at the life cycle cost for light bulbs. Life cycle cost is the initial cost of the appliance (in our case a light bulb) AND the cost of energy needed to use the appliance over its life. Use the *Light Bulb Comparison* to determine which light bulb has the lowest life cycle cost.

Initial cost of light bulb + Energy costs (electricity) = Life cycle cost of light bulb

 **Compact Fluorescent Bulb**	 **Incandescent Light Bulb**	 **Light Emitting Diode**
Amount of light = 850 lumens	**Amount of light = 850 lumens**	**Amount of light = 850 lumens**
Power in watts = 13 watts	**Power in watts = 60 watts**	**Power in watts = 12 watts**
Lifespan = 12,500 hours	**Lifespan = 1,000 hours**	**Lifespan = 25,000 hours**
Bulbs needed for 25,000 hours? 2	**Bulbs needed for 25,000 hours? 25**	**Bulbs needed for 25,000 hours? 1**
Cost per bulb = $3.00	**Cost per bulb = $ .50**	**Cost per bulb = $5.00**
Total bulb cost for 25,000 hrs? $ 6.00	**Total bulb cost for 25,000 hrs? $12.50**	**Total bulb cost for 25,000 hrs? $5.00**
13 watts X 25,000 hrs = 325,000 watt-hours	**60 watts X 25,000 hrs = 1,500,000 watt-hours**	**12 watts X 25,000 hrs = 300,000 watt-hours**
Kilowatt-hours (kWh)? 325	**Kilowatt-hours (kWh)? 1,500**	**Kilowatt-hours (kWh)? 300**
Cost per kWh = $ 0.13	**Cost per kWh = $ 0.13**	**Cost per kWh = $ 0.13**
Cost of electricity for 25,000 hrs 325 kwh x $0.13/kwh = $42.25	**Cost of electricity for 25,000 hrs 1,500 kwh x $0.13/kwh = $195.00**	**Cost of electricity for 25,000 hrs 300 kwh x $0.13/kwh = $39.00**
Life Cycle Cost $6.00 + $42.25 = **$48.25**	**Life Cycle Cost $12.50 + $195.00 =** **$207.50**	**Life Cycle Cost $5.0 + $39.00 =** **$44.00**

Calculate Life Cycle Savings:

IL Life Cycle Cost **$207.50** – CFL Life Cycle Cost **$48.25** = Life Cycle savings **$159.25**

IL Life Cycle Cost **$207.50** – LED Life Cycle Cost **$44.00** = Life Cycle savings **$163.50**

Facts of Light Summary

Use the *Facts of Light* data to show the life cycle cost of each bulb when used for 25,000 hours.

INCANDESCENT

$12.50 + $195.00 = $207.50

COST OF INCANDESCENT BULBS	COST OF ELECTRICITY	INCANDESCENT LIFE CYCLE COST
$12.50	$195.00	$207.50

FLUORESCENT

$6.00 + $42.25 = $48.25

COST OF FLUORSCENT BULBS	COST OF ELECTRICITY	CFL LIFE CYCLE COST
$6.00	$42.25	$48.25

LED

$5.00 + $39.00 = $44.00

COST OF LED BULBS	COST OF ELECTRICITY	LED LIFE CYCLE COST
$5.00	$39.00	$44.00

LESSON 4

Home Activity

Installing Light Bulbs

Safety note: Be sure to have an ADULT help with the installation of all light bulbs.

Materials

- Light Bulbs
- LED Nightlight (if available)

✔ Procedure

1. Share your *Facts of Light Summary* with your family. Explain how you collected your data and calculated the life cycle cost of each bulb.
2. How many total light bulbs are in your home? ______________
3. How much money could you save by replacing one incandescent bulb with a CFL?
4. How many CFLs or LEDs are in your home?

   _____ No CFLs or LEDs

   _____ 1-2 CFLs or LEDs

   _____ 3-4 CFLs or LEDs

   _____ > 4 CFLs or LEDs

5. Look at the nightlight (if available). The cost per year in electricity for an LED nightlight (plugged in constantly) is about $0.02. If you use the nightlight for 80 years, what would the electricity cost you?
6. Install your lightbulb(s) with an adult.

LESSON 4 – Lighting Investigation

ASSESSMENT

1. A CFL uses about __________ of the energy used by an incandescent light bulb.

   a. one fourth b. one tenth c. one half d. the same amount

2. An incandescent light bulb converts most of its energy into __________.

   a. light energy b. nuclear energy **c. thermal energy** d. mechanical energy

3. The average cost of one kilowatt-hour of electricity for homes in Ohio is _________.

   a. 25 cents b. $1.00 **c. 13 cents** d. 2 cents

4. One of the easiest and cheapest ways to reduce electricity use at home is to __________.

   a. replace windows b. add insulation to the attic

   c. replace an old refrigerator **d. change an IL to a CFL**

5. What do the letters CFL stand for? Why are CFLs more efficient?

   Compact Florescent Lightbulbs. CFLs are more efficient because of the technology used in producing the bulb, which allows it to produce more light than heat.

6. Why should you replace incandescent light bulbs with CFLs or LEDs and not wait until they burn out?

   If you wait until they burn out, you are wasting energy and money that could be saved by replacing immediately with a CFL or LED.

7. How do you calculate the life cycle cost of a light bulb?

   You calculate the cost of the bulb, plus the cost of the electricity to get the life cycle cost of the bulb.

Connections *(pg 48, Student and Family Guide)*

1. Explain how you would convince someone to replace an incandescent bulb with CFLs or LEDs.
2. Discuss the energy consumption of a CFL versus an IL using the results of the *Light Bulb Investigation*.
3. How did you calculate how much money you could save your family by replacing one incandescent bulb with a CFL?
4. Using what you learned in energy transformations, write out the energy transformations beginning with electricity for an incandescent light bulb.

Lesson 5: Appliances and Machines

Overview

This lesson examines the energy consumption of machines, appliances, and other electrical devices.

Objectives

- Students will be able to quantify their energy consumption by measuring the electrical load of common devices.
- Students will be able to calculate energy consumption for different appliances and machines.
- Students will be able to explain how the use of electronic devices and appliances contributes to greenhouse gas emissions.

Materials

- Watt meters
- Pluggable appliances (provided by teacher)

Masters

- *Kill A Watt™ Monitor (5-1)*
- *Measuring Electricity Use Chart (5-2)*

Student and Family Guide

- *Appliances and Machines Investigation*
- *The Environment and You*
- *Home Activity*
- *Assessment*
- *Connections*

Recommended Activities

- Vampire Power: www.occ.ohio.gov/publications/electric/Vampire_Power.pdf. Explore how appliances in standby mode still use electricity.

Home Energy Efficiency Kit Materials

- Refrigerator/Freezer thermometer

Preparation

- Review the operating instructions of the Kill A Watt™ monitor on the "Kill A Watt™ Monitor" (5-1) master.
- Gather pluggable devices students might see or use in school or at home.

Procedure

Measuring Electricity Use

1. Introduce the topic by discussing all of the machines in the classroom that use electricity. Have students read the Lesson 5 Background Information.
2. Display the *Kill A Watt Monitor (5-1)* Master explaining what it does and how it is operated.
3. Review the *Appliances and Machines Investigation* in the Student and Family Guide with the students. Have the students decide as a class which machines in the classroom they would like to investigate with the Kill A Watt™ monitor.
4. Assign students in groups to measure machines they would use in the classroom or at home, following the procedure on the *Appliances and Machines Investigation* activity. Instruct the student groups to estimate the hours per week and fill in the Appliance, Hours per Week, and Watts columns in their chart.
5. Display the *Measuring Electricity Use Chart (5-2)* master and review the example. Enter the machines the students investigated and work through the math with students. Have students share their data and complete data calculations independently or with group input.
6. Discuss the terms "Vampire Power" or "Phantom Power" with the students by reviewing the "Vampire Power" section in the Lesson 5 Background Information.

The Environment and You

1. Have students complete *The Environment and You* as a class to determine how much carbon dioxide each item would produce when in use. The carbon dioxide is emitted when generating the electricity to power the device. Discuss and go over the calculations as a class.

✔ Home Action Item and Wrap Up

1. Review the *Home Activity* in the *Student and Family Guide* with the students and assign a completion date.
2. Give each student a refrigerator/freezer thermometer or make sure they can identify it in their kit and how it can be used. Explain to students that the refrigerator or freezer is one of the appliances in their home that uses a large amount of energy. Remind students again that they must have an adult help them with this activity.
3. Have students complete the *Assessment* and *Connections* activities in the *Student and Family Guide.*

Background Information: Appliances and Machines

Electricity - What's a Watt?

We use electricity to perform many tasks. We use units called watts, kilowatts, and kilowatt-hours to measure the electricity that we use.

A **watt** is a measure of the electric power an appliance uses. Every appliance requires a certain number of watts to work correctly. Traditional light bulbs were rated by watts (60, 75, 100), as well as home appliances, such as a 1500-watt hairdryer. A **kilowatt** is 1,000 watts. It is used to measure larger amounts of electricity.

A **kilowatt-hour** (kWh) measures the amount of electricity used in one hour. Sometimes it's easier to understand these terms if you compare them to a car. A kilowatt is the *rate* of electric flow, or how much energy you are consuming at a specific instant. In a car, it would be similar to how fast you are driving at one instant. A kilowatt-hour is a quantity or amount of energy, or how much you consumed over a period of time. A kWh is like the distance traveled in a car.

We pay for the electricity we use in kilowatt-hours. Our power company sends us a bill for the number of kilowatt-hours we use every month. Most residential consumers in the United States pay about 13 cents per kilowatt-hour of electricity. In 2014, Washington state residents paid the least for electricity: 8.67 cents per kilowatt-hour. Hawaii residents paid the most: over 37 cents per kilowatt-hour.

How Much Is a Watt?

1 WATT
Small, LED flashlight

1.5 KILOWATTS = 1500 WATTS
Blow dryer

3 TO 5 MEGAWATTS =
3,000,000 to 5,000,000 WATTS
Diesel-electric locomotive engines

2 GIGAWATTS =
2,000,000,000 WATTS
Peak output of the Hoover Dam

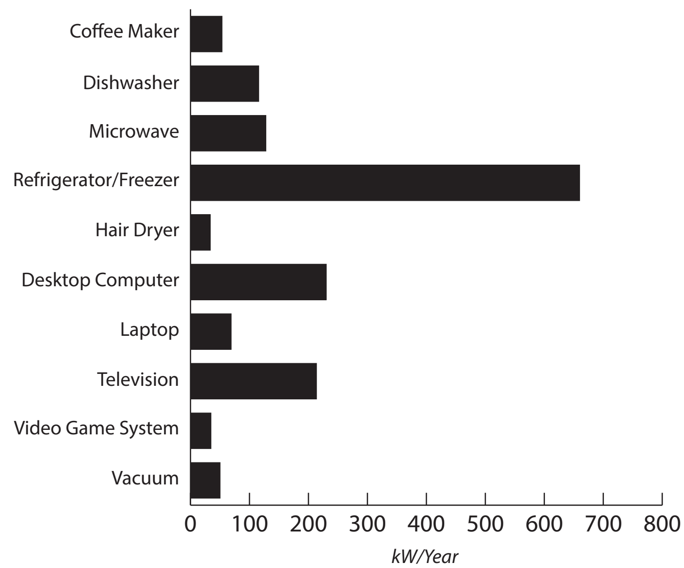
Cost of Electricity

How much does it cost to make electricity? It depends on several factors, such as:

- **Fuel Cost**: The major cost of generating electricity is the cost of the fuel. Many energy sources can be used. Hydropower is the cheapest way while solar cells are usually the most expensive way to generate electricity.
- **Building Cost**: Another key is the cost of building the power plant itself. A plant may be very expensive to build, but the low cost of the fuel can make the electricity economical to produce. Nuclear power plants, for example, are very expensive to build, but their fuel—uranium—is inexpensive. Coal-fired plants, on the other hand, are cheaper to build, but their fuel—coal—is more expensive.
- **Efficiency**: When figuring cost, you must also consider a plant's efficiency. Efficiency is the amount of useful energy you get out of a system. A totally efficient machine would change all the energy put in it into useful work. Changing one form of energy into another always involves a loss of usable energy.

In general, today's power plants use three units of fuel to produce one unit of electricity. Most of the lost energy is waste heat. You can see this waste heat in the great clouds of steam pouring out of giant cooling towers on some power plants. A typical coal plant burns about 4,500 tons of coal each day. About two-thirds of the chemical energy in the coal (3,000 tons) is lost as it is converted first to thermal energy, and then to motion energy, and finally into electrical energy.

How Much Electricity Do Appliances Use?



Data: DOE, Buildings Data Book

Appliances and Machines

Appliances, machines, and electronic devices use about 24 percent of a typical household's energy, with refrigerators, freezers, clothes washers and dryers at the top of the list. Any appliance that is designed to change temperature uses a lot of energy. You can save energy by:

- turning off appliances and machines when you aren't using them;
- using the energy-saver setting on dishwashers and refrigerators;
- keeping the doors closed as much as possible on refrigerators and freezers—know what you want before you open the doors;
- being aware that many machines use energy even when turned off—save energy by unplugging them; and
- using machines and appliances during the morning and evening, not during peak demand time.

When you shop for a new appliance, you should think of two price tags. The first one covers the purchase price—the down payment. The second price tag is the cost of operating the appliance. You'll pay the second price tag on your utility bill every month for the next 10 to 20 years. An energy efficient appliance will usually cost more, but it will save a lot of money in energy costs. An energy efficient model is almost always a better deal.

ENERGY STAR®

When you shop for a new appliance, look for the **ENERGY STAR®** label—your guarantee that the product saves energy. ENERGY STAR® qualified appliances incorporate advanced technologies that use less energy and water than standard models. A list of energy efficient appliances can be found on the ENERGY STAR® website at www.energystar.gov.

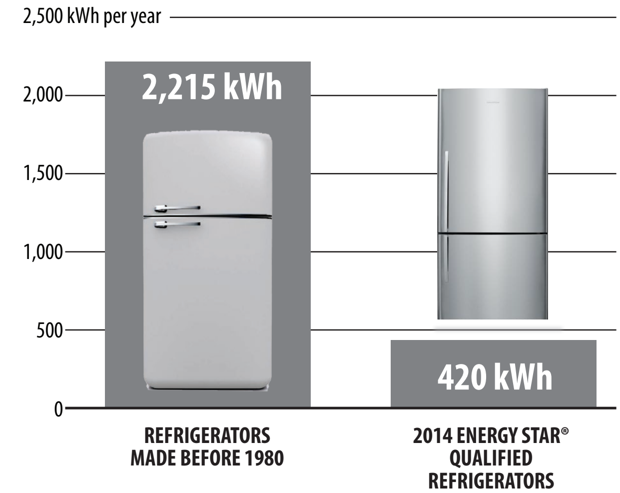
CHANGE FOR THE BETTER WITH ENERGY STAR

Vampire Power

Household appliances and electronics contribute to a significant portion of the expenses seen on monthly electric bills. What consumers may not know is a large part of that expense could be a result of items that are not even used. According to energy experts, about 5 to 10 percent of a home's electricity is used by appliances that are in standby mode. In Ohio, that means approximately $55 to $110 per year could be saved on your electric bill if you knew which electronics and other household items have standby modes and took action to lower this power use. This electricity "loss" also is referred to as vampire power.

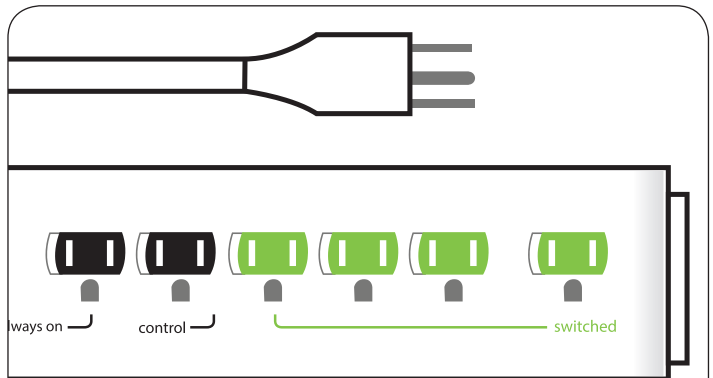
Many everyday appliances and electronics use significant power while in standby mode. The use and amount depends on the individual product; however, some of these appliances that use vampire power include: clock radios, satelitte/cable boxes and digital video recorder (DVR) equipment, televisions, DVD and VCR players, video game consoles, computers and monitors, printers, and microwaves.

Refrigerator Efficiency



Data: ENERGY STAR®

SMART POWER STRIPS



Many electronics go into standby mode when turned off. Reduce vampire power by plugging electronics into a smart power strip, which can turn electronics off completely.

Kill A Watt™ Electricity Consumption Monitor

The Kill A Watt™ monitor allows users to measure and monitor the power consumption of any standard electrical device. You can obtain instantaneous readings of voltage (volts), current (amps), line frequency (Hz), and electric power being used (watts). You can also obtain the actual amount of power consumed in kilowatt-hours (kWh) by any electrical device over a period of time from one minute to 9,999 hours. A kilowatt is 1,000 watts.

Operating Instructions

1. Plug the Kill A Watt™ monitor into any standard grounded outlet or extension cord.
2. Plug the electrical device or appliance to be tested into the AC Power Outlet Receptacle of the Kill A Watt™ monitor.
3. The **LCD** displays all meter readings. The unit will begin to accumulate data and powered duration time as soon as the power is applied.
4. Press the **Volt** button to display the voltage (volts) reading.
5. Press the **Amp** button to display the current (amps) reading.
6. The **Watt** and **VA** button is a toggle function key. Press the button once to display the Watt reading; press the button again to display the VA (volts x amps) reading. The Watt reading, not the VA reading, is the value used to calculate kWh consumption.
7. The **Hz** and **PF** button is a toggle function key. Press the button once to display the Frequency (Hz) reading; press the button again to display the power factor (PF) reading.
8. The **KWH** and **Hour** button is a toggle function key. Press the button once to display the cumulative energy consumption. Press the button again to display the cumulative time elapsed since power was applied.

What is Power Factor?

The formula **Volts x Amps = Watts** is used to find the energy consumption of an electrical device. Many AC devices, however, such as motors and magnetic ballasts, do not use all of the power provided to them. The power factor (PF) has a value equal to or less than one, and is used to account for this phenomenon. To determine the actual power consumed by an AC device, the following formula is used:

Volts x Amps x PF = Watts Consumed

LESSON 5

Appliances and Machines Investigation

Question

Which items are the largest energy consumers in your school or home?

Materials

- Kill A Watt™ monitor
- Pluggable appliances

Hypothesis

✔ Procedure

Calculate how much it costs to operate the machines in your classroom or home. You need to know the wattage, the cost of electricity, and the number of hours a week each machine is used. You can find the wattage by plugging the machine into the watt meter.

You can estimate the number of hours the machine is used each week, then multiply by 40 to get the yearly use. We are using 40 weeks for schools, because school buildings aren't used every week of the year. Using the copier as an example, if it is used for ten hours each week, we can find the yearly use like this:

Yearly use = 10 hours/week x 40 weeks/year = 400 hours/year

Remember that electricity is measured in kilowatt-hours. You will need to change the reading from the watt meter (in watts) to kilowatts. One kilowatt is equal to 1,000 watts. To get kilowatts, you must divide the watts by 1,000. For example, if the copier used 1,265 watts on the watt meter you would divide like this:

kW = W/1,000
kW = 1,265/1,000 = 1.265

The average **cost of electricity in Ohio is about thirteen cents ($0.13)** a kilowatt-hour. You can use this rate or find out the actual rate from your school's electric bill. Using the average cost of electricity, we can figure out how much it costs to run the copier for a year by using this formula:

Yearly cost	**=**	**Hours used**	**x**	**Kilowatts**	**x**	**Cost of electricity (kWh)**		
Yearly cost	**=**	**400 hours/year**	**x**	**1.265 kW**	**x**	**$0.13/kWh**		
Yearly cost	**=**	**400**	**x**	**1.265**	**x**	**$0.13/kWh**	**=**	**$65.78**

MACHINE OR APPLIANCE	HOURS PER WEEK	HOURS PER YEAR	WATTS (W)	KILOWATTS (kW)	RATE ($/kWh)	ANNUAL COST
Copier	*10*	*400 hours*	*1,265 W*	*1.265 kW*	*$0.13*	*$65.78*

Measuring Electricity Use Chart

MACHINE OR APPLIANCE	HOURS PER WEEK	HOURS PER YEAR	WATTS (W)	KILOWATTS (kW)	RATE ($/kWh)	ANNUAL COST
Copier	*10*	*400*	*1,265 W*	*1.265 kW*	*$0.13*	*$65.78*

LESSON 5

The Environment and You

When we breathe, we produce carbon dioxide. When we burn fuels, we produce carbon dioxide, too. Carbon dioxide (CO_2) is a greenhouse gas. Greenhouse gases hold heat in the atmosphere. They keep our planet warm enough for us to live, but since the Industrial Revolution, we have been producing more carbon dioxide than ever before. Since 1850, the level of CO_2 in the atmosphere has increased 44.3 percent.

Research shows that greenhouse gases are trapping more heat in the atmosphere. Scientists believe this is causing the average temperature of the Earth's atmosphere to rise. They call this global climate change or global warming. Global warming refers to an average increase in the temperature of the atmosphere, which in turn causes changes in climate. A warmer atmosphere may lead to changes in rainfall patterns, a rise in sea level, and a wide range of impacts on plants, wildlife, and humans. When scientists talk about the issue of climate change, their concern is about global warming caused by human activities.

Driving cars and trucks produces carbon dioxide because fuel is burned. Heating homes by burning natural gas, wood, heating oil, or propane produces carbon dioxide, too.

Making electricity can also produce carbon dioxide. Some energy sources—such as hydropower, solar, wind, geothermal, and nuclear—do not produce carbon dioxide, because no fuel is burned. About 38.6 percent of our electricity, however, comes from burning coal. Another 30.4 percent comes from burning natural gas, petroleum, and biomass.

The general rule is that, on average, every kilowatt-hour of electricity produces 1.23 pounds of carbon dioxide. Let's use this rule to figure out how much carbon dioxide is produced by the machines in your classroom. You can put the figures from the earlier worksheets in the boxes below. Here are the figures for the copier:

CO_2 a year = wattage x hours of use x rate of CO_2/kWh

CO_2 a year = 1.265 kW x 400 hr/yr x 1.23 lb/kWh = 622.38 lbs

MACHINE OR APPLIANCE	KILOWATTS (kW)	RATE OF CO_2/kWh (LBS)	HOURS PER YEAR	CO_2/YEAR (LBS)
Copier	*1.265 kW*	*1.23*	*400 hours*	*622.38*

LESSON 5

Home Activity

APPLIANCES AND ENERGY STAR® LOGOS

Materials

- Refrigerator thermometer
- Dollar bill

✔ Procedure

1. With the help of an adult, test the seal on the door of your refrigerator. To do this, you will need a dollar bill. Close the door over the dollar bill so that it is half in and half out of the refrigerator. Grasp the end of the bill with both hands by the corners and pull slowly and steadily. Do not try to jerk it; it might tear. A refrigerator with a tighter seal (dollar bill does not move) is more efficient and uses less energy. You can save energy and money by keeping the refrigerator door closed tightly.

    ______ comes out easily

    ______ comes out fairly easily

    ______ comes out with difficulty

    ______ does not move

2. Use the refrigerator thermometer to measure the temperature of your refrigerator and freezer and record in the chart below.

APPLIANCE	TEMPERATURE	SAFE ZONE (°F)
Refrigerator		37°-40°
Freezer Section		0°-5°
Separate Freezer (if applicable)		0° or Colder

3. Look around your house for large or small appliances that have ENERGY STAR® logos on them. Explain to your family that the ENERGY STAR® means the appliances meet strict energy efficiency standards. What ENERGY STAR® appliances did you find?

CHANGE FOR THE BETTER WITH ENERGY STAR

LESSON 5 – Appliances and Machines

ASSESSMENT

1. Most appliances are powered by ___________.

   a. natural gas **b. electricity** c. propane d. petroleum

2. One of the appliances that uses the most energy in your home is the ___________.

   a. refrigerator b. computer c. radio d. television

3. One kilowatt is equal to _________ watts.

   a. 10 b. 100 **c. 1,000** d. 10,000

4. A fan and a hair dryer both move air. How do the watts used by each compare? Explain why there is such a difference.

   While a fan and a hair dryer both move air, the hair dryer uses many more watts and uses energy at a greater rate. The reason for the difference is that the hair dryer has a heating element to heat the air. It requires much more electricity to be transformed into both mechanical energy and thermal energy.

5. Explain how an appliance could have a lower wattage than another but still cost more per year for electricity. Give examples.

   An appliance with a lower wattage could still cost more for electricity to run each year because electricity is measured and consumed in kilowatt-hours (kwh) not just kilowatts. The watts are important but also the time that the appliance is being used. An example of this is that a light bulb that is used often and for long periods of time could have a low wattage and still cost more per year than a hair dryer which is high wattage but only used for very short periods of time.

Connections *(pg 55, Student and Family Guide)*

1. Describe a Kill A Watt™ monitor and explain how it can be used to help save energy.
2. Share how reducing carbon dioxide in the atmosphere can have an impact on the environment.
3. Looking at the appliances in your home, how can you make your current appliances more efficient? What will you look for when your family purchases a new one?

Lesson 6: What We Have Learned

Overview

Students review what they have learned and what changes they have made to use less energy at school and at home.

Objectives

- Students will be able to differentiate between energy efficiency and energy conservation, citing examples of each concept.
- Student will report the energy efficiency measures installed in their home on the Family Installation Survey.

Student and Family Guide

- *Home Installation Survey log on information*
- *Connections*
- *Energy Glossary*
- *Internet Resources*

✔ Procedure

1. Discuss what the students have learned from the unit and what they think their families have learned.
2. Discuss the successful installation and use of the items in the Home Energy Efficiency Kit. Have students complete the *Family Installation Survey*.

   OPTIONAL: Send a paper copy of the *Family Installation Survey* home with students to have families complete and return it as an assignment. Then take students to the computer lab to input data. Download the current year's survey at www.ohioenergy.com.
3. Have students complete the *Connections* questions and discuss as a class.

✔ Procedure after Completion of Unit

1. Have students enter installation survey data (at www.ohioenergy.com) using the school's computer lab, or mail paper copies of installation survey to:

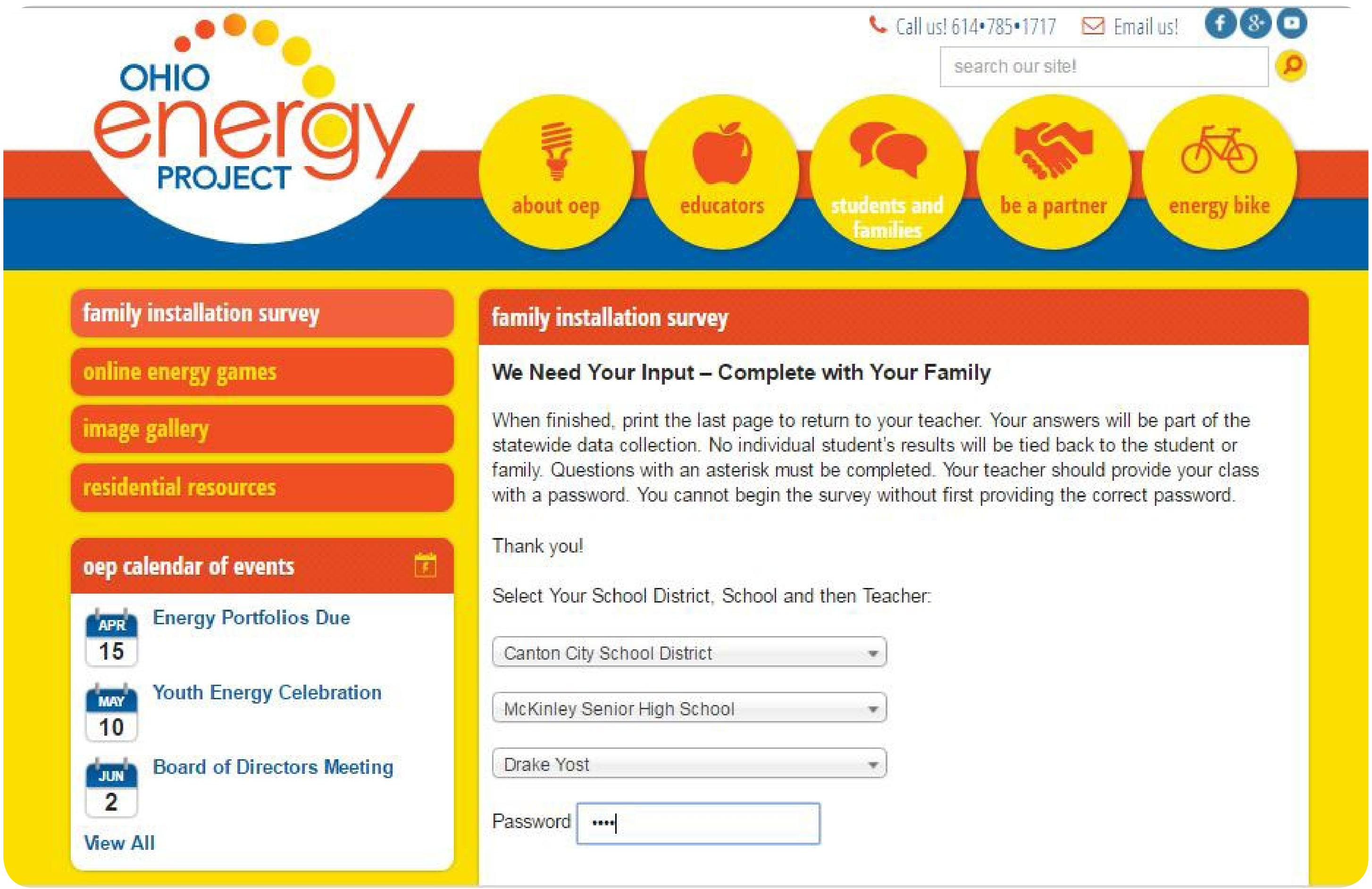
   Ohio Energy Project
   200 E. Wilson Bridge Rd.
   Suite 320
   Worthington, OH 43085.
2. Complete the teacher evaluation at www.ohioenergy.org.
3. Register for next year's program at www.ohioenergy.org.

LESSON 6

Family Installation Survey

This program is funded through your local electric and/or natural gas provider. We ask all families to complete this survey to measure the energy savings from the program. Thank you for making a difference and saving money with your energy efficiency actions.

Please visit www.ohioenergy.org to complete the survey.



Connections *(pg 57, Student and Family Guide)*

1. What are the most important things you have learned about energy and how to save it?
2. What energy concepts would you like to learn more about?
3. What things do you think you and your family will do to save energy at home?
4. How will saving energy now impact your life later as an adult?

Tips to Save Energy

▪Install a programmable thermostat to lower utility bills and manage your heating and cooling systems efficiently.

▪Air-dry dishes instead of using your dishwasher's drying cycle.

▪Turn off appliances and devices when you are not in the room or when they are not in use.

▪Put devices like TVs, DVD players, stereo equipment, and lights into smart power strips. Electronics in standby mode can still use several watts of power.

▪Call 811 before you dig.

▪Lower the thermostat on your water heater to 120ºF.

▪Take short showers instead of baths and use low-flow showerheads for additional energy savings.

▪Wash only full loads of dishes and clothes.

▪Check to see that windows and doors are closed when heating or cooling your home.

OHIO energy PROJECT

www.ohioenergy.org

NEED National Energy Education Development

www.need.org