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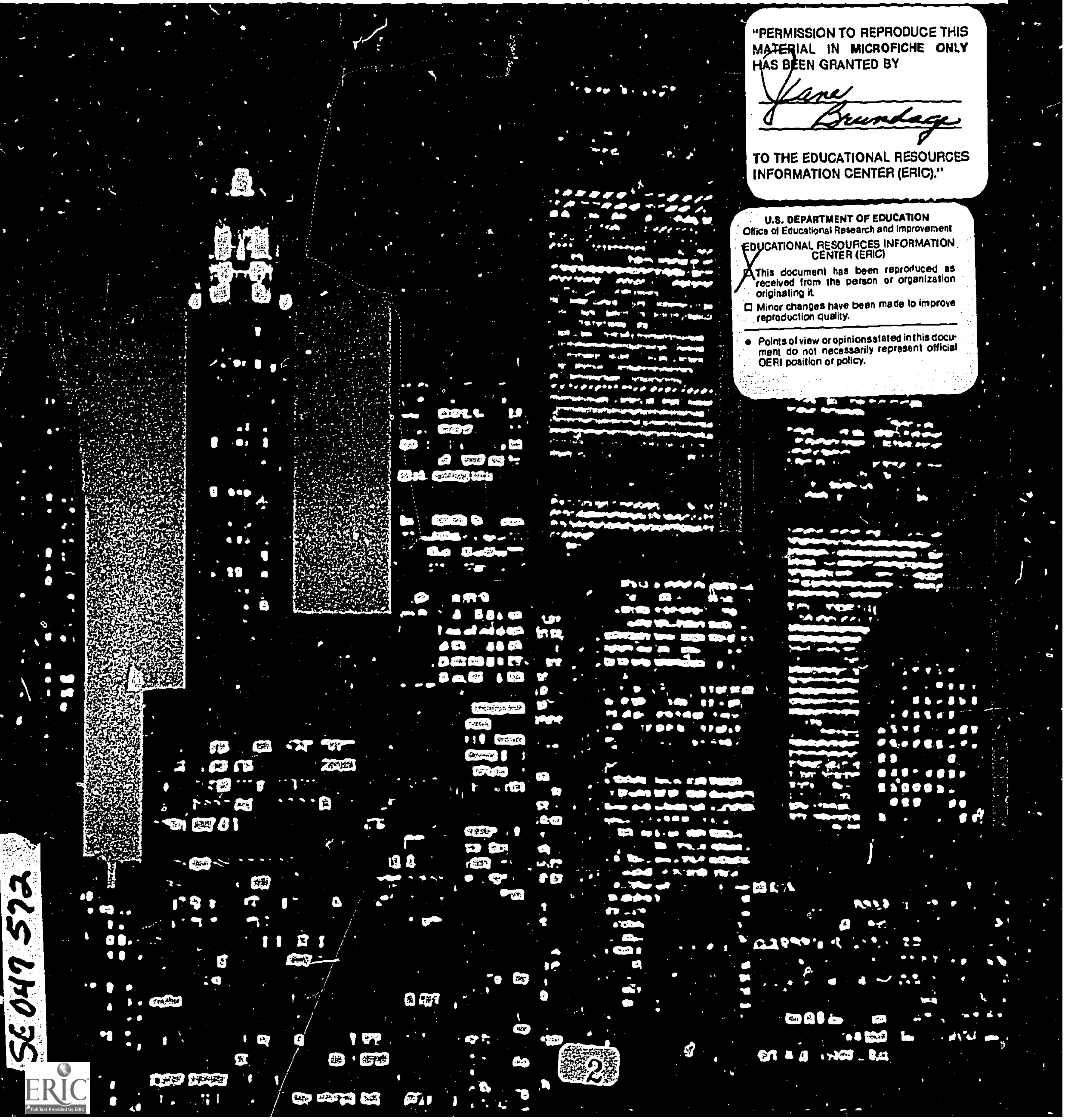
ABSTRACT

The Science in Action series is designed to teach practical science concepts to special-needs students. It is intended to develop students' problem-solving skills by teaching them to observe, record, analyze, conclude, and predict. This document contains a student workbook which deals with basic principles of physical science. Six separate units include: (1) what is energy; (2) burning fuels; (3) fuels from under the ground; (4) electricity; (5) solving energy problems; and (6) what can you do. The units consist of basic introductory information and questions, worksheets, a self-checking quiz, and instructions for experiments. A cumulative test is provided at the end of the workbook, along with a glossary. The teachers guide (which is included) explains how to use the workbook, together with teaching suggestions and enrichment activities for each unit. (TW)

Energy

Physical Science in Action



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Energy

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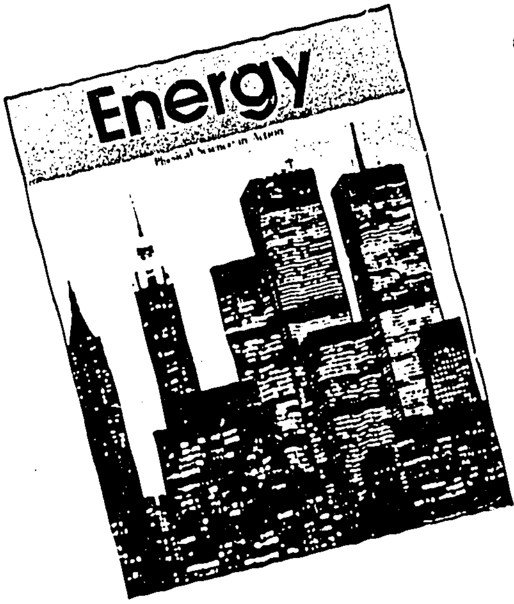

Teacher's Manual

Energy

Cary I. Sneider, Ph.D. and
Henri Picciotto, M.A.

A Janus **Physical Science in Action** Book

Teacher's Manual written by Cary I. Sneider, Ph.D. and Henri Picciotto, M.A.

OVERVIEW

Making Science Real

Can your special-needs students handle physical science materials? We believe they can—if those materials are practical and relevant to their everyday experiences.

We wrote ***Energy*** for the older adolescent with learning difficulties. Hands-on activities invite students to actively participate in their own learning. Clear explanations and easy-to-do experiments and activities make basic scientific principles easy to understand.

A Janus ***Science in Action*** workbook, *Energy* provides a basic description of energy and its uses. Students learn about the kinds of energy they use day-to-day, and ways to use them wisely. At the same time, they learn important physics concepts and expand that learning through a variety of enrichment activities.

Success for the Slow Learner

Energy was written specifically for students with learning difficulties. Complex scientific concepts are broken down into easy-to-handle steps, then immediately reinforced by interesting activities and experiments. Lessons are paced for slow learners, and exercises formatted so students can do them.

Energy is part of a set of Janus ***Physical Science in Action*** books. (Other sets in the Janus *Science in Action* program are ***Life Science in Action*** and ***Earth Science in Action***.) This workbook helps your students meet general science and laboratory science requirements. *Energy* can be used as a supplement to or as the core of your science program.

OBJECTIVES OF THE WORKBOOK

The Janus *Science in Action* series is designed to help special-needs students learn basic and practical science concepts that can be applied to daily living. It also helps students develop problem-solving and thinking skills by teaching them to observe, record, analyze, conclude, and predict.

Objectives of *Energy* are to help the student:

- know the basic forms that energy takes;
- understand how energy is changed into forms we can use;
- learn the main sources of energy and the advantages and disadvantages of using those sources;
- learn a basic vocabulary for discussing energy and its use;
- learn some ways to use energy wisely.

READABILITY

The average reading level of *Energy* is below 2.5, according to the revised Spache Readability Formula. Words that are particularly useful for understanding science concepts are listed as target words under "Teaching the Units" in this manual. They are also listed and defined in a glossary at the end of the workbook. Target words are set in boldface type whenever they first appear in the text.

We suggest you review the target words in each unit before students work on that unit. Help students pronounce the words. Encourage them to look up definitions in the glossary. Reinforce recognition and comprehension of the words through word games and oral and written vocabulary activities.

HOW TO USE THE BOOK

The Workbook Format

As with all Janus *Science in Action* books, *Energy* is formatted so your students can easily recognize what to do as they work through the book.

Most units begin with a one-page introduction that prepares students for the teaching that follows. The introduction includes topic questions that focus students on the concepts they will learn, as well as a brief vocabulary exercise, "Before You Start."

Lessons are one- or two-pages long and are followed by an activity or experiment. Units end with a short comprehension exercise, "Check Yourself," and a list of additional activities, "Check These Out," that reinforce or expand the teaching in the unit. The activities are multi-modal so that all students can handle at least one of them successfully.

Introducing the Book

Ask students what these things have in common: a campfire, a speeding car, a brightly lit lamp. Guide students to say that all three have energy; then ask the class to list similar things that have energy. Help students see that energy plays a very important part in their lives.

Pass out books for students to leaf through. Point out some interesting lessons and activities. Then select a student to read the introduction out loud.

Introducing the Unit

Put up posters and pictures that illustrate the unit's subject matter. Read the unit introduction, and ask students to guess the answers to its questions. (Have them refer to the pictures and posters for clues.) Students can jot down their answers, and compare them to answers they give again after finishing the unit.

Review any words students may need extra help with. Then have students do "Before You Start."

Teaching Suggestions

Be Prepared!

A science lesson can end up in unpredictable ways! So, always read through lessons and try out activities in advance. Consider minor adjustments your students may require in materials or procedures. Decide if some experiments could better be presented to your class as demonstrations. You might also have students work together as teams.

Have all materials for a lesson ready at the start of class. Keep supplementary reading materials and activities on hand for those students who finish their work ahead of others.

Structure the Learning

We suggest you keep your class together as they work through the book. Provide continuity by reviewing what was last learned and previewing what comes next. Encourage discussions of the questions in the text. Bring in guest speakers. Announce relevant news programs and community events.

Supervise students closely during the experiments and activities. Try to anticipate problems your students may encounter, and structure the activities to minimize those difficulties. Have an extra supply of those materials that might be damaged or lost.

The End of the Book

When students finish *Energy*, have them do the comprehensive exercises under "Show What You Learned." "What's the Answer?" is a brief exercise that tests comprehension of the major concepts taught in the book. "What's the Word?" tests knowledge of some target words.

About the Glossary

The glossary at the end of the book lists and defines all target words that appear in boldface type in the text. Words are listed alphabetically and divided into syllables. Definitions reflect only the way words are used in text. The glossary can also serve as an introduction to or a reinforcement of dictionary skills.

TEACHING THE UNITS

Unit 1: What Is Energy?

Target Words: *motion, potential energy, stored*

Energy is difficult to define because it takes many forms. Students read about common forms of energy and learn how they use the forms in daily life.

PAGE 5: **Stuck in the Woods!**

Most of the energy we use can be classified as motion energy, light energy, or heat energy. Have your students brainstorm solutions to the energy problem posed on this page. Help students see how that problem illustrates our dependence on motion, heat, and light.

PAGE 6: **What Gives You Energy?**

Students list familiar objects that provide them with heat, light, and motion energy. On the chalkboard, list all your students' answers. Accept any reasonable idea.

PAGE 7: **Changing Energy**

One of the most important ideas of physics is that energy can be transformed from one form to another. Students learn that the potential energy stored in certain materials can be transformed to heat, light, or motion. Students identify the forms of energy that those materials produce. Almost any answer is acceptable; for instance, while we burn wood for heat or light, the fire can also set smoke or sparks in motion.

PAGE 8: **Check Yourself**
Across 2. motion **3.** change **4.** light
Down **1.** potential **5.** heat

Enrichment Activities

- Bring in pictures or show a film about life in a preindustrialized society. Discuss how people used energy then.
- Decorate the classroom with students' posters ("Check These Out" #2). Refer to them when working through Unit 2.
- Take your class to an auto shop. Find out how cars produce heat, light, and motion.

Unit 2: Burning Fuels

Target Words: *engine, fuel*

Most of the energy we use comes from burning fuels. Students learn specific uses we make of several different fuels.

PAGE 10: **Energy from Fuel**

Students look at pictures and decide which form of energy we want when we burn certain fuels. Before they answer the questions, have students discuss what is going on in each picture. After they answer, ask them to think of other similar fuels.

PAGE 11: **The Right Fuel for the Job**

Students identify several common fuels and learn some of our major uses of them. Ask students if they know of other uses for those fuels. **1. c.** kerosene; **d.** white gas **2. e.** diesel fuel; **f.** aviation fuel **3. a.** natural gas; **b.** butane

PAGES 12–13: **Experiment 1—Which fuel is better for cooking? Which fuel is better for light?**

Materials: *votive candles, cans of Sterno, pitcher of water, foil tart pans, foil loaf pans, scissors, felt pens, stapler, kitchen matches.*

Students compare the heat and light produced by two kinds of fuel. The most difficult part of the experiment is building the stoves, so prepare as much as you can ahead of time to help students do the experiment successfully. Make a model for students to refer to. Cut foil pans in halves for each student. When the experiment is over, observe the safety warning about extinguishing Sterno flames.

Observations: 1. The Sterno stove boils water first. **2.** The candle stove gives off more light. **3.** The Sterno stove gives off more heat. It makes water boil faster.

Conclusions: 1. Sterno is a better cooking fuel because it gets water hotter. **2.** Candles are better for light because they give off more light.

PAGE 14: **Check Yourself**

1. Wood, gasoline, and butane are *fuels.* **2.** Fuels have *potential* energy stored inside of them. **3.** A fuel gives energy when it is *burned.* **4.** Fuels burn in the *engines* of cars. **5.** Charcoal and *natural gas* are burned for heat energy. **6.** Gasoline and *diesel fuel* are burned for motion energy. **7.** White gas and *candle wax* are burned for light energy.

Enrichment Activities

- Collect news articles about fuel issues and concerns. Discuss them with your students.
- Demonstrate that fire needs air: Light a candle and cover it with a jar. The candle will go out when the air is used up.

Unit 3: Fuels from Under the Ground

Target Words: *coal, crude oil, fossil, fossil fuels, mine, natural gas, products, refinery*

Students learn what fossil fuels are, how they are extracted from Earth, and how we use them.

PAGE 16: **Fossil Fuels**

Fossil fuels are the remains of long-dead plants and animals. They are found in gas, liquid, and solid forms. Review what a gas, liquid, and solid are. Ask for examples of common gases, liquids, and solids. At the end of the lesson, students think of how life would be different without fossil fuels (no fast transportation; we'd burn lots of wood; etc.). Encourage discussion of this question.

PAGE 17: **Digging for Coal**

Students learn how coal is mined. Help them understand by copying the diagram on the chalkboard. Then ask students to supply missing words. Bring in a lump of coal to show your class.

PAGE 18: **Fuel from Crude Oil**

Students learn how crude oil is extracted and refined into products. Bring in a drill and a block of wood to demonstrate how a hole can be cut through hard material. Explain that derricks use the same method to make shafts.

PAGE 19: **Check Yourself**

1. (Most of our energy) **c.** comes from fossil fuels.
2. (Some fossil fuels are) **e.** coal, oil, and natural gas.
3. (Fossil fuels are the remains of things) **b.** that lived millions of years ago. **4.** (We get coal by) **f.** mining it out of the ground. **5.** (We use oil wells to get oil) **a.** and natural gas out of the ground.
6. (Refineries turn crude oil) **d.** into gasoline and other products.

Enrichment Activities

- Collect petroleum products: asphalt, lubricating oil, Vaseline, Styrofoam and plastic objects, etc. Explain that all are made from crude oil.
- Coal was the material that fueled the Industrial Revolution. Get pictures or films that illustrate steam locomotives and other important uses of coal in the nineteenth century.

Unit 4: Electricity

Target Words: *appliance, generator, magnet, magnetism, meter, power plant, produce, rotor wheel*

A commonly used form of energy is electricity. Students learn what electricity is used for and how it is generated.

PAGE 21: **Electrical Energy**

Appliances change electrical energy into forms we use (heat, light, motion). Students identify the forms of energy that various appliances provide. Students can extend their lists to include appliances not mentioned on the page.

PAGES 22–23: **Electricity from a Battery**

Materials: *flashlight batteries, small sockets, flashlight bulbs that fit the sockets (make sure they can be lit by a 1.5-volt battery), bell wire*

Students see that batteries produce electricity. The most difficult part of this activity is stripping the wire. Before class, you may want to strip all the wires with a sharp knife or scissors. If students have difficulty getting their bulbs to light, check for (a) poor connections; (b) dead batteries; (c) burned-out bulbs.

What Happens? **1.** The bulb lights up when it is connected to the battery. **2.** Electrical energy makes the bulb light up. **3.** Energy comes from the battery. **4.** The battery's energy is changed into light.

PAGE 24: **Electricity from a Generator**

Materials: *bulb and socket from the previous activity, bicycle generator*

Students find out that generators also produce electricity. If you have only one generator, do this as a class demonstration. If you want students to do the activity but you can't afford bicycle generators, substitute small, inexpensive electrical motors. (These can be found in some hobby and electronics shops.)

What Happens? **1.** My fingers give motion energy. **2.** The moving wheel of the bicycle turns the rotor wheel.

PAGE 25: **Inside a Generator**

A generator works when its coil of wire passes through its magnetic field. You can show that the generator contains a magnet by using it to pick up staples or paper clips. If possible, take a generator apart to show the coil of wire and magnets.

PAGE 26: **Electricity from Running Water**

Electricity that a community uses is generated in power plants. Students learn that power plants use generators that work on the same principles as the bicycle generator they studied. In hydroelectric power plants, the rotor wheel is turned by running water.

PAGE 27: **Electricity from Steam**

Students learn that steam is used to turn the rotor wheel in some power plants. Point out this kind of power plant's dependence on fossil fuel.

Be sure students understand that all power plants make electricity the same way—with a generator and rotor wheel. The only difference is the form of energy used to turn the rotor wheel. Find out from your utility company how electricity is produced for your town.

PAGE 28: **Meet Your Meter**

Students learn that electric use is measured by an electric meter. Point out that adjacent dials on the meter turn in opposite directions. Show students the electric meter in your school. For a complete explanation on how to read meters, contact your local utility company for materials and a demonstration.

PAGE 29: **How Much Electricity?**

Students use simple arithmetic to calculate electricity used. Go through the process step by step. Ask students to bring in old electric bills from home. Talk about what the figures on the bills stand for.

PAGE 30: **Check Yourself**

1. (A battery makes electricity) **c.** with chemical energy. **2.** (A generator makes electricity) **b.** with motion energy. **3.** (A rotor wheel moves) **a.** a coil of wire inside a generator. **4.** (A hydroelectric power plant) **e.** gets motion energy from water. **5.** (Some power plants use steam) **f.** to turn the rotor wheels. **6.** (An electric meter measures) **d.** how much electricity you use.

Enrichment Activities

- Bring in a battery tester and demonstrate its use. Explain that the tester is a kind of meter that measures electricity coming from the battery.
- Show students how to read the school's gas meter.

Unit 5: Solving Energy Problems

Target Words: *exhaust, heat collector, insulator,*

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nuclear fuel, pollute, radioactive, silicon, solar cell, uranium-235, wind generator

The tremendous rate at which we burn fossil fuels causes serious environmental, economic, and social problems. Students learn the pros and cons of using nuclear, solar, and wind power as alternatives.

PAGE 32: **Too Much Smoke!**

Students review causes and effects of air pollution. Then they think of ways to cut down on air pollution (use less fuel; make more efficient engines; use unleaded gas; filter factory smoke; use alternative sources of energy; etc.) Have students discuss their answers.

PAGE 33: **Digging Deeper**

We can run out of affordable fossil fuels. Students learn why and think of alternative fuels.

PAGE 34: **Nuclear Energy**

This page teaches that a nuclear power plant works the same way as a steam power plant. The steam, however, is produced by heat from nuclear fuel rather than fossil fuel. Bring in relevant newspaper articles and discuss the advantages and disadvantages of nuclear power.

PAGE 35: **Wind Energy**

Wind is increasingly being used to generate electrical energy. Although wind is a clean source of energy, it has limitations. Students conclude that wind is unreliable because it doesn't always blow.

PAGE 36: **Electricity from the Sun**

People use solar cells to get electrical energy from the sun. Students conclude that solar cells, like wind, are clean and renewable sources of electric power; but they are also unreliable. Bring in a solar-powered calculator or pictures of solar-powered cars.

PAGE 37: **Heat from the Sun**

Solar energy can also be used for heat. Find photos or brochures on solar water heaters. If you can, show students an actual solar water heater on a roof. (Note: The water pipes are usually soldered to the back of the heat collector, so they are not visible from the street.)

PAGES 38–39: **Experiment 2—Which material makes a good insulator?**

Materials: *loaf pans, metal cups or cans, Styrofoam cups, kettle of hot water, pitcher of cold water, ice cubes*

Students learn the function of insulation when they compare metal and Styrofoam as insulators. You may want to pour the hot water for your students.

Observations: **1.** The water is hotter in the Styrofoam cup. **2.** The ice melted faster around the metal cup.

Conclusions: **1.** The metal let out more heat. **2.** Styrofoam keeps water hotter. **3.** Styrofoam makes a good insulator.

PAGE 40: **Check Yourself**

Across **3.** clean **6.** insulator **7.** wind **8.** exhaust *Down* **1.** nuclear **2.** radioactive **4.** solar **5.** pollute

Enrichment Activities

- Illustrate the pollution from a car. Tie a piece of cheesecloth over the end of your car's exhaust pipe for a day. Then show it to the class.
- Write to NASA (address in "Resources" section of this manual) for free pictures or films of satellites and spacecraft that use solar cells and nuclear reactors for energy.
- Make a solar water heater: Paint cans or pans black. Fill them with water. Put them in a sunny window.

Unit 6: What Can You Do?

Target Word: *conserve*

Students think of ways they can help solve energy problems and save on energy bills.

PAGE 41: **What Can You Do?**

Students review our major energy-consuming devices. Then they think of ways to conserve on energy. List their ideas on the chalkboard.

PAGE 42: **Save on Gasoline**

This page lists some ways to conserve gasoline; students think of other ways. Invite a driver's training teacher to discuss fuel efficiency with your class.

PAGE 43: **Save on Electricity**

This page describes ways to cut down on electricity consumption. Have students make posters and stickers reminding others to save electricity by turning off lights, etc. Post them around the school near light switches. Typical messages might be: *Turn Me Off! Save Electricity! Conserve Energy!*

PAGE 44: **Save on Heat**

Students read about ways to conserve heat. Ask them what they remember about the insulation experiment (pages 38–39). Point to each picture, and ask questions like: *Which is the best insulator: an open window, a closed window, or a closed window with drapes?*

PAGE 45: **Save Energy at Home**

This page suggests some additional ways to conserve energy at home. Ask how each of the suggestions helps save money. Point out that hanging clothes out to dry uses solar and wind energy. Assign homework: Ask students to take their books home, show them to their families, and get further suggestions on how to conserve energy.

Show What You Learned

PAGE 46: **What's the Answer?**

1. a. Heat, light, motion. **2. c.** It is changed to heat, light, and motion. **3. b.** Burning.
4. a. Steam; **b.** Running water; **c.** Wind.
5. a. In batteries and generators; **b.** In solar cells and power plants. **6. b.** Crude oil, natural gas. **c.** coal, nuclear

PAGE 46: **What's the Word?**

1. Fuel **2.** Potential **3.** Generator **4.** Pollute **5.** Solar Cells **6.** Insulator **7.** Conserve

TEACHING AIDS

Resources

The science department of a nearby college or museum often has suggestions or materials you can use. Ask your local utility company for brochures on energy production and conservation.

The following organizations have information in print or on film that you may find useful:

- Agency for Instructional Television, Box A, Bloomington, IN 47401
- Electrical Power Research Institute, P.O. Box 10412, Palo Alto, CA 94303
- Lawrence Hall of Science, University of California, Berkeley, CA 94720
- National Aeronautics and Space Administration (NASA), Public Affairs Division, Washington, D.C. 20546
- National Center for Appropriate Technology, P.O. Box 3838, Butte, MT 59702
- National Energy Foundation, 323 Geary St. #314, San Francisco, CA 94102
- U.S. Committee for Energy Awareness, 1735 I St. NW, Ste. 500, Washington, D.C. 20006
- U.S. Department of Energy, Technical Information Center, P.O. Box 62, Oak Ridge, TN 37830

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The Dam Builders, by James E. Kelly and William R. Park. Addison-Wesley, 1977.
Electricity and How We Use It, by Tillie S. Pine and Joseph Levine. McGraw-Hill, 1982.
The First Book of Electricity, by Sam and Beryl Epstein. Franklin Watts, 1977.
First Films on Science: Teacher's Guide. Agency for Instructional Television.
Harnessing the Sun: The Story of Solar Energy, by David C. Knight. William Morrow and Co., 1976.
"ISTA Spectrum." University of Illinois, Spring, 1983.
Matter and Motion: Teacher's Guide. National Instructional Television (now called Agency for Instructional Television), 1973.
Oil and Gas: From Fossils to Fuels, by Hershell and Joan Lowery Nixon. Harcourt, Brace, Jovanovich, 1977.
Petroleum, Gas, Oil, and Asphalt, by Irving Adler. The John Day Company, 1975.
Solar Energy, by John Hoke. Franklin Watts, 1968.
Solar Energy for Tomorrow's World, by Reed Millard et al. Julian Messner, 1980.

Introduction

Picture this:

It's late afternoon. It is time to go home, and you're waiting for a bus.

You look around. Cars and buses fill the street. Motorcycles roar by. An airplane flies overhead.

The sun sets, and you feel cold. You put on your sweater. Street lights come on. Lights in buildings come on too.

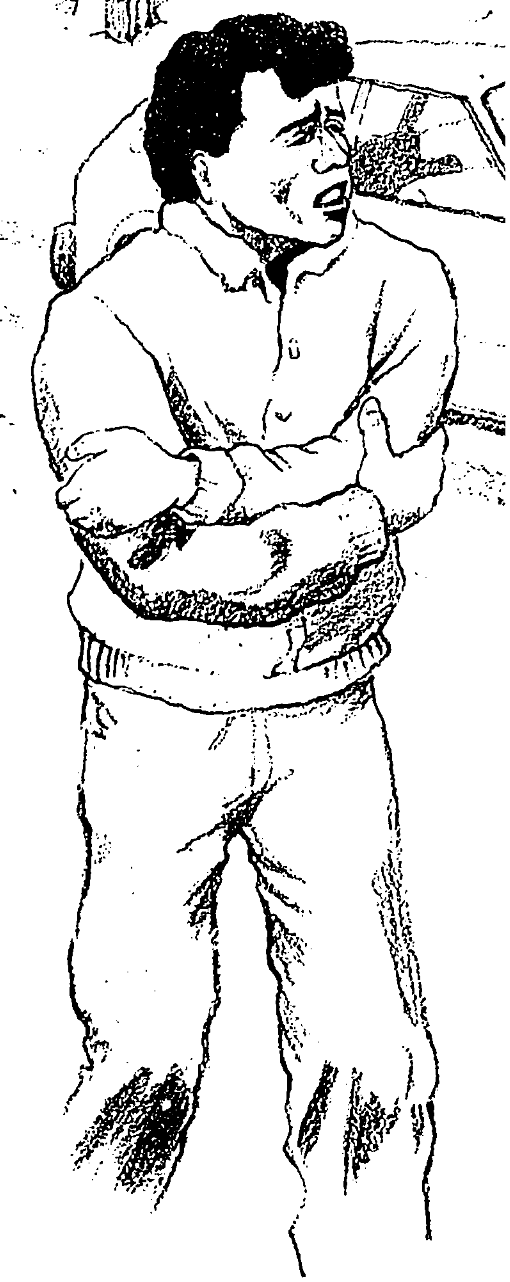
Your bus pulls up and you get on. Soon you'll be home. You'll turn on the heater and warm your house. You'll cook your dinner, then watch TV. At bedtime, you'll set the alarm on your electric clock.

Everything you saw and did took energy. Energy moved the cars, buses, motorcycles, and airplane. Energy gave you light and heat. Energy ran your TV and clock.

Energy is all around us. We use it to make our lives easier and more comfortable. We use it to make things and do work. We use it to keep us alive. Can you imagine living without any energy at all?

This book is about the energy you use. You'll find out where that energy comes from. You'll learn how it is used. You'll see how important energy is in your life. And you'll also learn ways to use energy wisely.

When you finish this book, you'll know many facts about energy that you didn't know before. And you'll know some ways to use it better.



Unit 1

What Is Energy?

You use energy in many different ways. You use it to cook your food. You use it to get to school or work. And you use it to light up a dark place. In fact, you use a *lot* of energy, every day.

Even though you use energy all the time, you probably don't think about it much. But without energy you could not live. Energy is all around you. You use many kinds of energy.

- What are some kinds of energy?
- How do you use energy?
- Where do you get energy?

You will learn the answers in this unit.

Before You Start

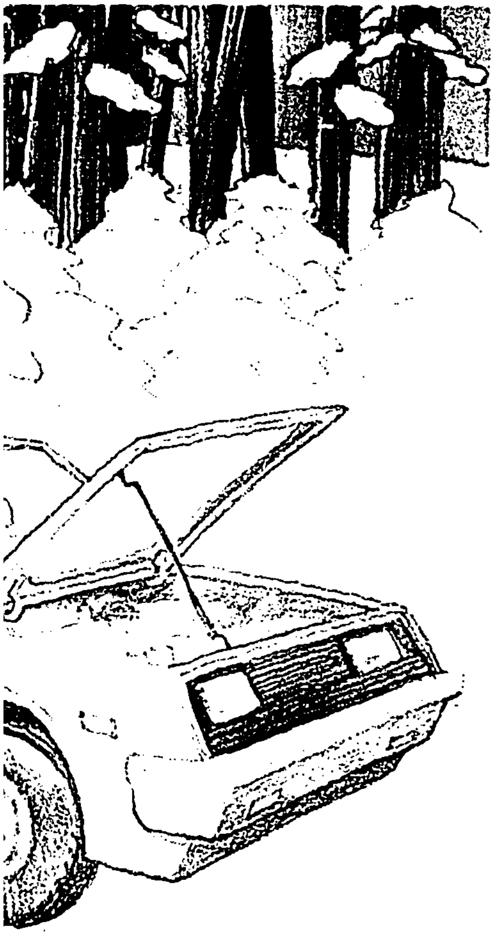
You'll be using the science words below. Find out what they mean. Look them up in the Glossary that's at the back of this book. On the lines below, write what the words mean.

1. **motion** ____________________

____

2. **stored** ____________________

____



Stuck in the Woods!

Picture this:

You're driving down a road. Your car is moving along. It's in *motion*.

The sky starts getting dark. Night is coming. You can't see the road very well, so you turn on the car's headlights. They *light* the road.

Now it starts to snow. You're getting cold. You turn on the car's heater. It sends *heat* into the car. Soon you are nice and warm.

You're now using three kinds of energy. What do you think they are?

Motion, light, and heat are the three kinds of energy you're using.

All of a sudden, your car stops! Your lights go out and your heater stops working. You can't get the car to start up again. You are cold, you have no light, and you are stuck in the woods. You have an energy problem! What would you do?

That's an example of what could happen when you can't get motion, light, and heat energy. They are three kinds of energy you use every day. Without them, your life could be very hard. What would your life be like if you couldn't get motion, light, and heat energy?

What Gives You Energy?

You learned that heat, light, and motion are kinds of energy. What are some things that give you those kinds of energy?

Heat Energy

What is something that gives off heat to warm you?

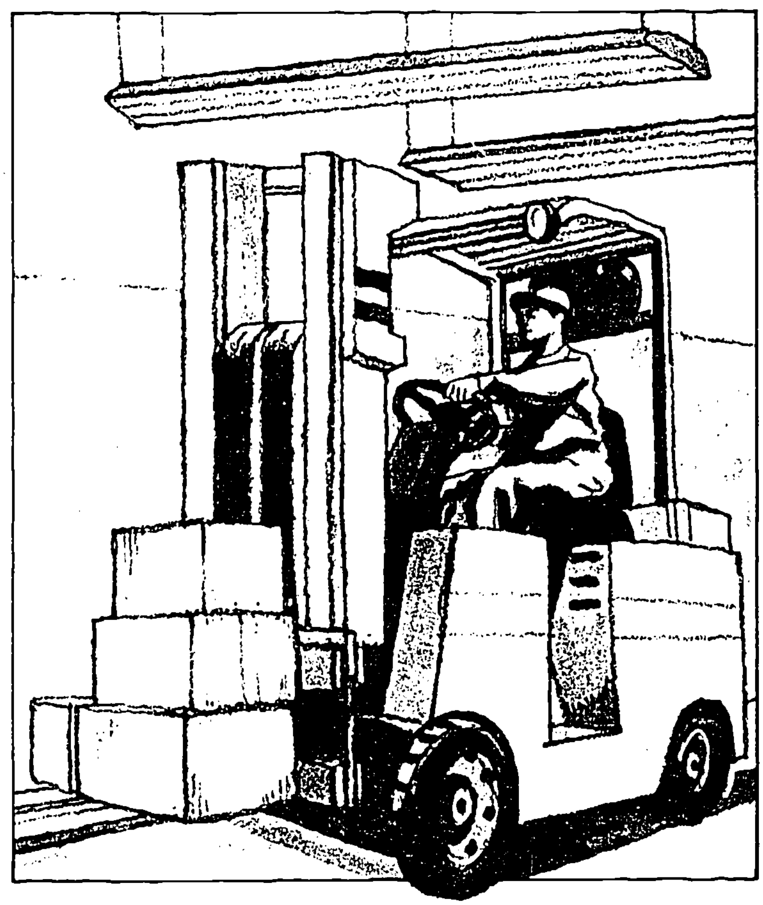
What gives you heat to cook with?

Light Energy

What is something that gives you light indoors?

What is something that gives you light outdoors?

What is something you can carry that gives you light?



Motion Energy

What is something that moves you from home to school or work?

What is something that moves you on a river, lake, or ocean?

What is something that helps people move heavy things?

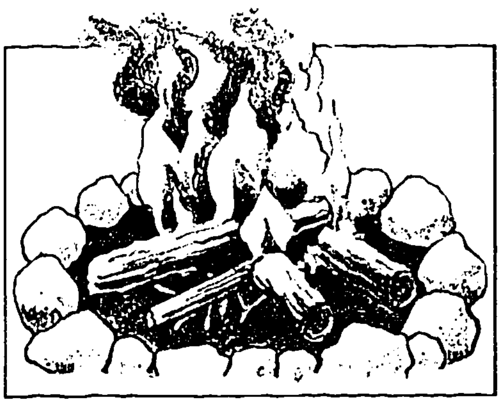
Changing Energy

Think of a piece of paper. Does it have motion, heat, or light energy?

It doesn't have any of those kinds of energy. But it can! That's because paper has **potential energy**. Potential energy is a kind of energy that is stored inside of something.

Scientists say that energy cannot be made. It can only be *changed* from one kind of energy into another kind. How can the potential energy in paper be changed into light energy?

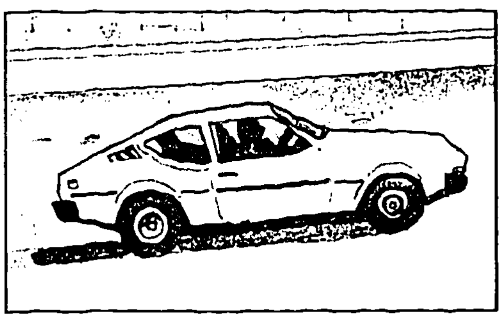
Right! When you burn paper, the potential energy inside it is changed into light energy. It is also changed into heat energy.



The pictures on this page show some things that had potential energy. What kind of energy did that potential energy change into? Put an X in front of your answers. Then check your answers. (The right answers are upside down.)

1. Wood has potential energy. When you burn wood, the potential energy is changed into what two kinds of energy?

   _____ a. heat _____ b. light _____ c. motion



2. Gasoline has potential energy. When you drive a car, the engine burns gasoline. The car moves. The potential energy in gasoline is changed into what kind of energy?

   _____ a. heat _____ b. light _____ c. motion

3. A battery has potential energy. When you use it in a flashlight, that potential energy is changed. What kind of energy is it changed into?

   _____ a. heat _____ b. light _____ c. motion

Answers

1. We burn wood to get heat and light energy. 2. We burn gasoline to get motion energy. 3. We use a battery in a flashlight to get light energy.

Check Yourself

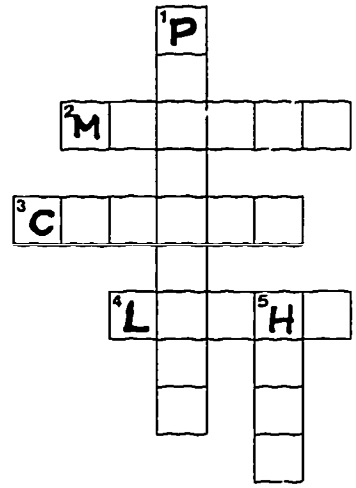
Use words from this unit to do the crossword puzzle. The clues below will help you. In the puzzle, each word is started for you. Check your spelling by looking at the page after each clue.

Across

2. A kind of energy that can move things. (page 5)
3. You can't make energy. You can only __________ it from one kind to another kind. (page 7)
4. A kind of energy that helps you see things. (page 5)

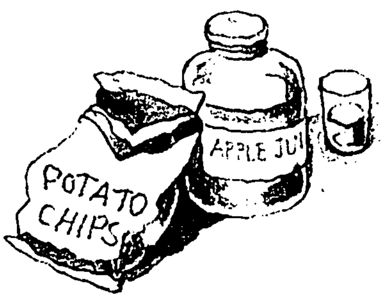
Down

1. Stored energy that is waiting to be used. (page 7)
5. A kind of energy that can cook food. (page 5)



Check These Out

1. Find out more about energy in your car. Ask a mechanic to talk to your class. Ask that person these questions: How does the car's heater work? Where do the headlights get their energy? How does the engine work?
2. Look through some magazines. Find pictures that show energy being used. Cut them out and put them in these three groups: heat, light, and motion. Make posters of the three groups.
3. Food gives people energy to move. This energy is measured in *calories*. Find out how many calories certain foods have. Get a food calorie chart from the library. Or look at the labels on cans and other food packages. Those labels often list the number of calories in the food. Bring those labels to class.
4. As you work through this book, you may want to find out more about energy. You can find out more by looking in a dictionary, an encyclopedia, or by getting books about energy at the library. You can also talk to an expert, such as a physics teacher, someone at a utility company, or someone at an ecology center.
5. Here are some things you may want to find out:
   - What is the science of *thermodynamics?* How do engineers use this science?
   - What does *conservation of energy* mean? Give some examples.
   - What is *horsepower?*
   - What kinds of energy did cave people use? What kinds of energy do people use today?



Unit 2

Burning Fuels

Fire! It is the most important energy discovery of all time. Fire gives us heat and light energy. It also gives us motion energy.

But in order to have a fire, something must burn. We burn many different things every day. They are our most important sources of energy.

- What do people burn for energy?
- How do people use the energy from burning things?

You'll find the answers in this unit.

Before You Start

You'll be using the science words below. Find out what they mean. Look them up in the Glossary. On the lines below, write what the words mean.

1. **engine** ______________________________

____

2. **fuel** ______________________________

____

Energy from Fuel

We call things that we burn *fuel.* A good fuel has a lot of potential energy stored in it. When we set that fuel on fire, the fire changes its potential energy into heat, light, or motion.

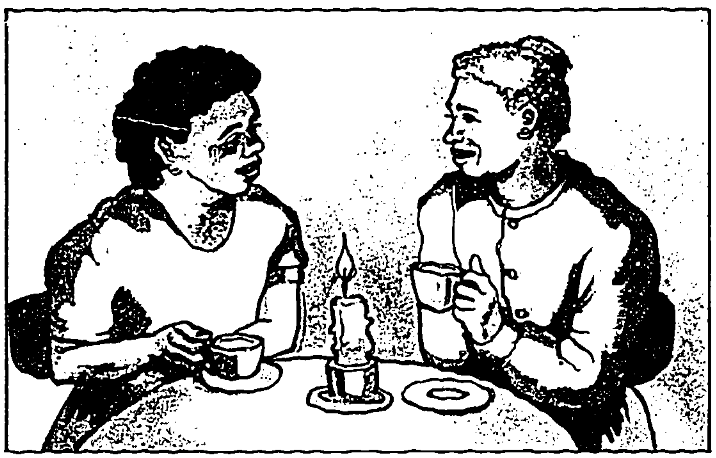
The pictures show some fuels being burned. They are fuels people use every day. Look at the pictures and answer the questions. Then check your answers. (The right answers are upside down.)

1. The people in the top picture are having a barbecue. What fuel are they burning?

   ____

   What energy is that fuel giving?

   ____

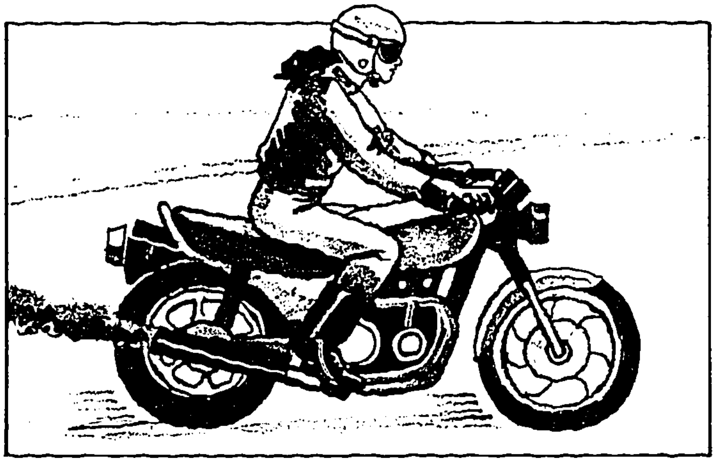


2. The power went out in the middle picture. The lights don't work. What fuel are the people burning?

   ____

   What energy is that fuel giving?

   ____



3. The girl is riding a motorcycle. The motorcycle has an engine. The engine works by burning fuel. What fuel is the engine burning?

   ____

   The engine changes some of the potential energy of the fuel into another kind of energy. What kind is it?

   ____

Answers

1. People burn charcoal to get *heat* energy.
2. People burn candle wax to get *light* energy. 3. The engine burns gasoline and gets *motion* energy.

The Right Fuel for the Job

People use different fuels for different jobs. Some fuels are used for light. Some are used for heat. And some are used for motion.

The pictures on this page show six fuels that are being used for different reasons.

1. Which two fuels are being used for light?

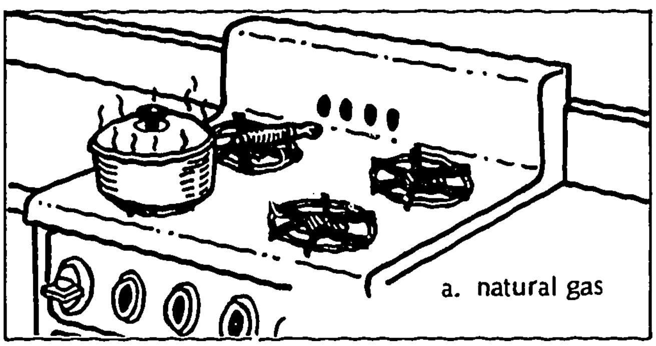
_______________ _______________

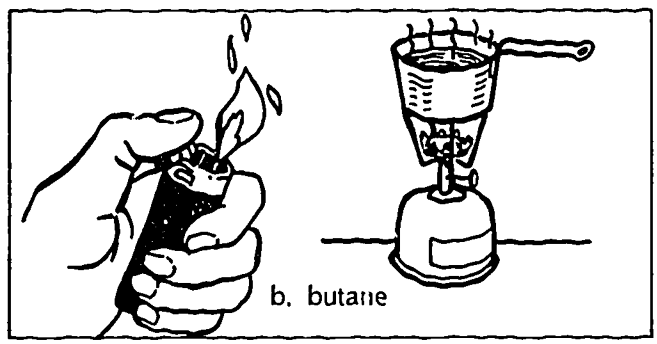
2. Which two fuels are being used for motion?

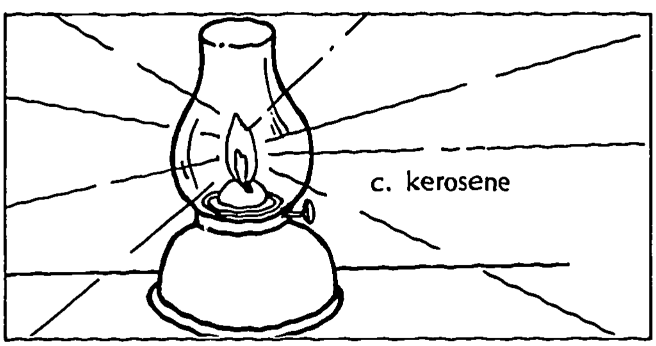
_______________ _______________

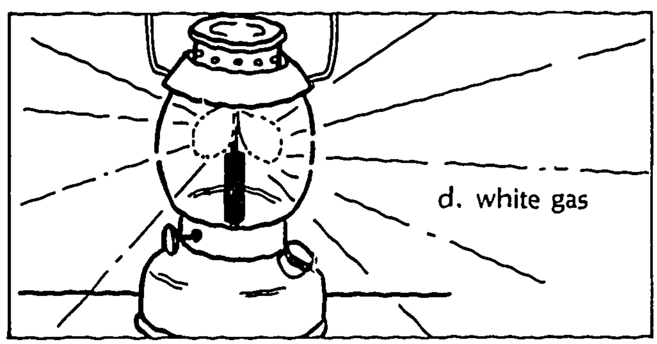
3. Which two fuels are being used for heat?

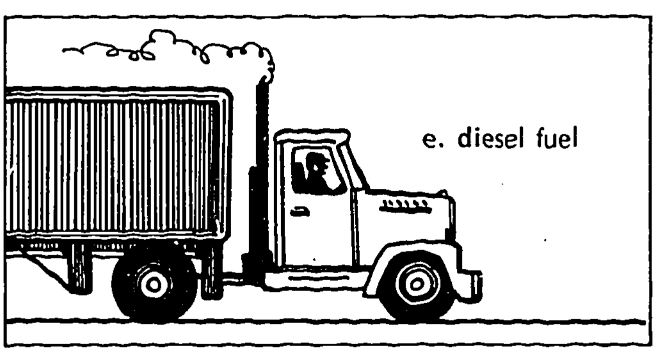
_______________ _______________

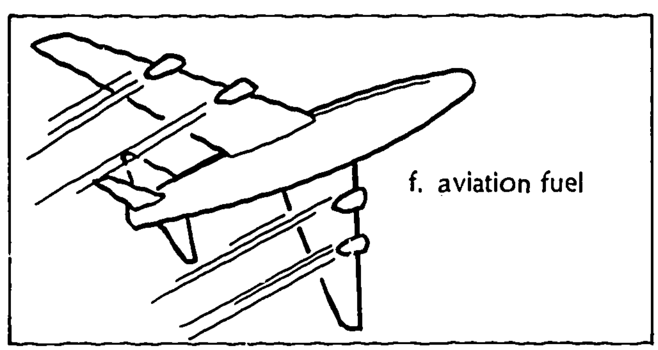

a. natural gas


b. butane


c. kerosene

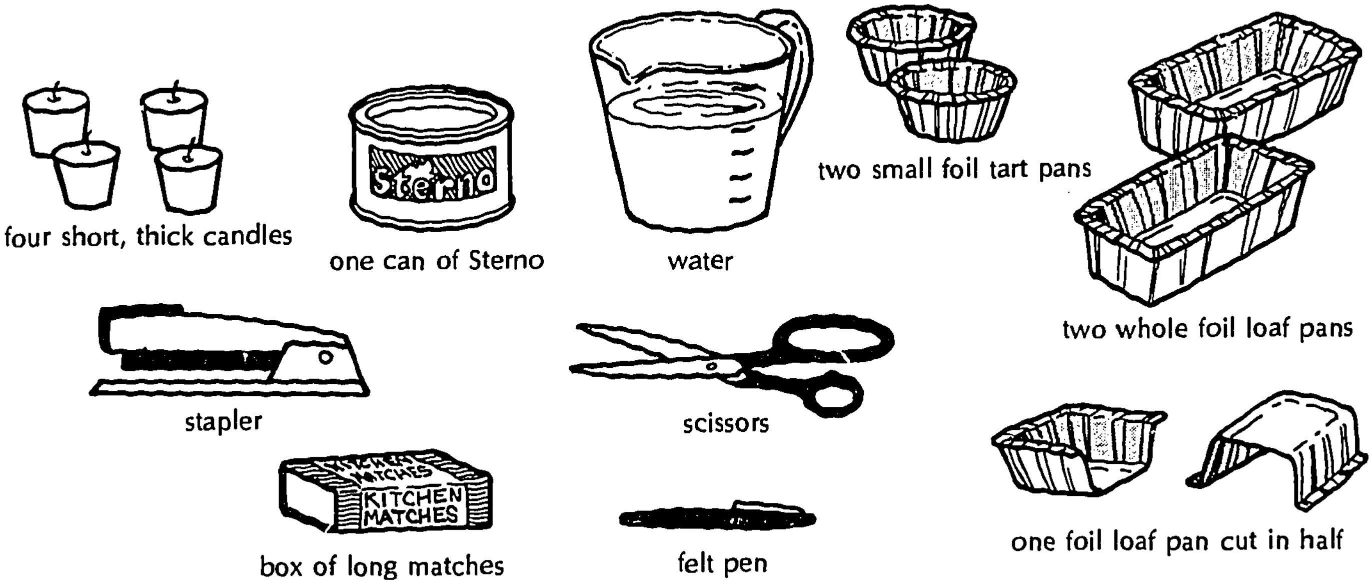

d. white gas


e. diesel fuel


f. aviation fuel

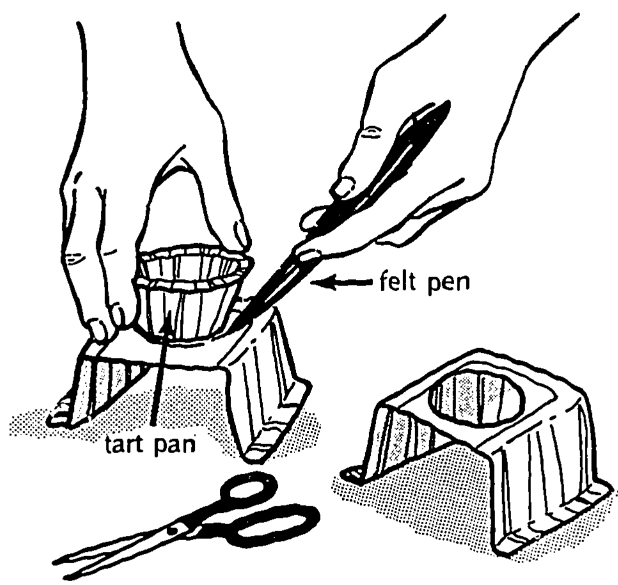
Experiment 1
Which fuel is better for cooking?
Which fuel is better for light?

Materials (What you need)



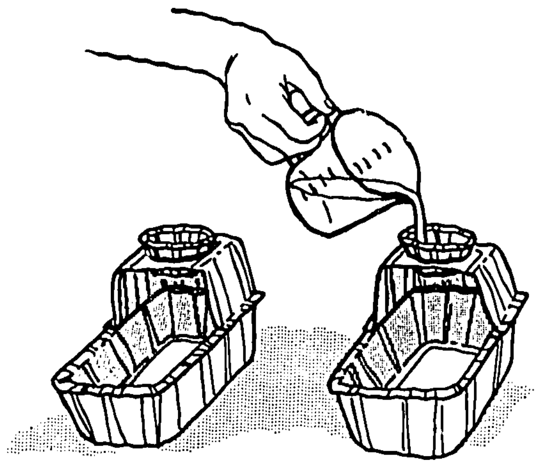
Procedure (What you do)

1. First draw a hole on the bottom of each half pan. The hole should be a little bigger than the bottom of a tart pan. Then cut out the hole.

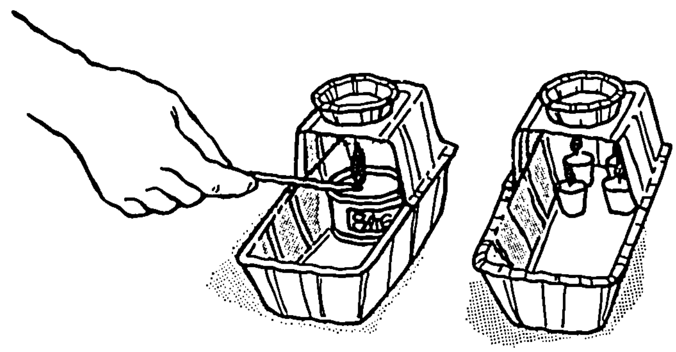


2. Then make two "stoves" like this: Staple a half pan to each whole pan.

3. Fit a tart pan into the hole on each "stove." Fill the pans about half full with water.



4. Put the candles under one pan. Take the lid off the Sterno and put the can under the other pan. Light the candles and the Sterno. Wait until the water boils.



Observations (What you see)

1. Which "stove" boils water first: the one with Sterno or the one with candles?

____

2. Which "stove" gives off more light?

____

3. Which "stove" gives off more heat?

____

How do you know?

____

Conclusions (What you learn)

1. Which fuel is better for cooking? Why?

____

____

2. Which fuel is better for light? Why?

____

____

Important!

Put out the flames:

1. Slide the Sterno lid onto the can. The flame will go out right away. Do not blow out the Sterno flame!
2. Blow out the candles.

Check Yourself

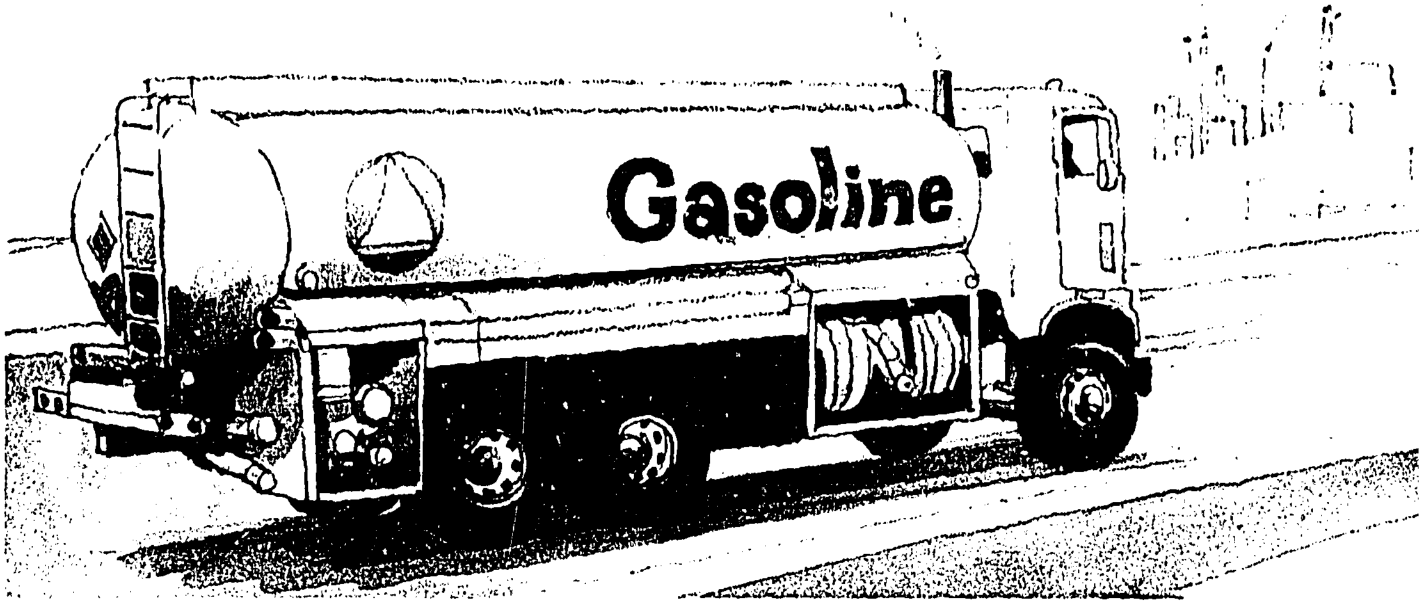
Show what you learned in this unit. Finish these sentences. The words you'll need are listed below.

burned	**candle wax**	**fuels**
engines	**natural gas**	**potential**
	diesel fuel	

1. Wood, gasoline, and butane are ______________ .
2. Fuels have __________________________ energy stored inside of them.
3. A fuel gives energy when it is ________________ .
4. Fuels burn in the ____________________ of cars.
5. Charcoal and ____________________ _________ are burned for heat energy.
6. Gasoline and ________________ ___________ are burned for motion energy.
7. White gas and _______________ _________ are burned for light energy.

Check These Out

1. Try to hard-boil an egg on one of the "stoves" you made for the experiment on pages 12-13. Use the fuel that makes the most heat. Cook the egg in boiling water for about ten minutes. Turn it over with a spoon, and cook it five more minutes. Then, eat your egg.
2. Which is the better fuel for a barbecue: wood or charcoal? Find out — *outdoors*. You will need two barbecue grills and two pieces of the same kind of meat. The pieces should be the same size. Start a wood fire in one grill and a charcoal fire in the other. Cook a piece of meat on each fire. Compare the results.
3. What are *regular, premium,* and *unleaded* gasolines? Ask someone who works at a gas station.
4. Invite someone from your town's fire department to talk to your class. Ask that person how to store fuels safely and prevent fires.
5. People from different countries have legends and myths about fire. Do you know one? Tell it to your class.
6. What are good safety rules about using fire? Make a poster.
7. Here are more things you may want to find out:
   - What is *combustion?* Spontaneous combustion?
   - How does an *internal combustion* engine work?
   - What happens to fuel when it burns? What is *oxidation?*
   - Why do matches work?
   - What's in Sterno? Why does it burn?



Unit 3

Fuels from Under the Ground

You depend on cars, buses, and home furnaces every day. Those things work because they burn fuels that come from under the ground.

Your clothes and many of the things you use are made by machines in factories. Those machines work because of fuels that come from under the ground.

Our way of living today depends on burning huge amounts of fuel. Almost all of that fuel comes from under the ground.

- What fuels come from under the ground?
- How do we use those fuels?
- How do we get those fuels?

You'll learn the answers in this unit.

Before You Start

You'll be using the science words below. Find out what they mean. Look them up in the Glossary. On the lines below, write what the words mean.

1. **fossil** ______________________________

____

2. **mine** ______________________________

____

3. **products** ______________________________

____

Fossil Fuels

Imagine the Earth millions of years ago, long before there were people. Many of the plants and animals were different from the kinds we see today. Strange-looking fish filled the oceans. Giant dinosaurs walked through forests. Those forests covered much of the land.

All those plants and animals died. Many were buried under mud and sand. As years went by, layers of dirt and rocks covered them. For millions of years tons of dirt and rock pressed down. What happened to those dead plants and animals?

Right! They began to rot. And then they changed. They slowly turned into materials that could be burned. Those materials are called **fossil fuels**. Why are they called *fossil* fuels?

Fossils are the remains of plants and animals that lived millions of years ago. So, fossil fuels are the remains of ancient living things that have turned into fuels.

A fossil fuel can be a gas, a liquid, or a solid.

Gas fossil fuel is called **natural gas**. Natural gas is used for cooking and heating homes.

Liquid fossil fuel is called **crude oil**. Crude oil is made into gasoline, butane, kerosene, aviation fuel, diesel fuel, and other products.

Coal is one kind of solid fossil fuel. It is used in factories to make steel, cement, paper, and other things we use every day.

How would your life be different if there were no fossil fuels? (Think about how you get around town, cook your food, or heat your house.)

22

Digging for Coal

Burning a rock? You may find that surprising, but it happens every day. Coal is a black rock that makes a lot of heat when it is burned. Coal is also a fossil fuel.

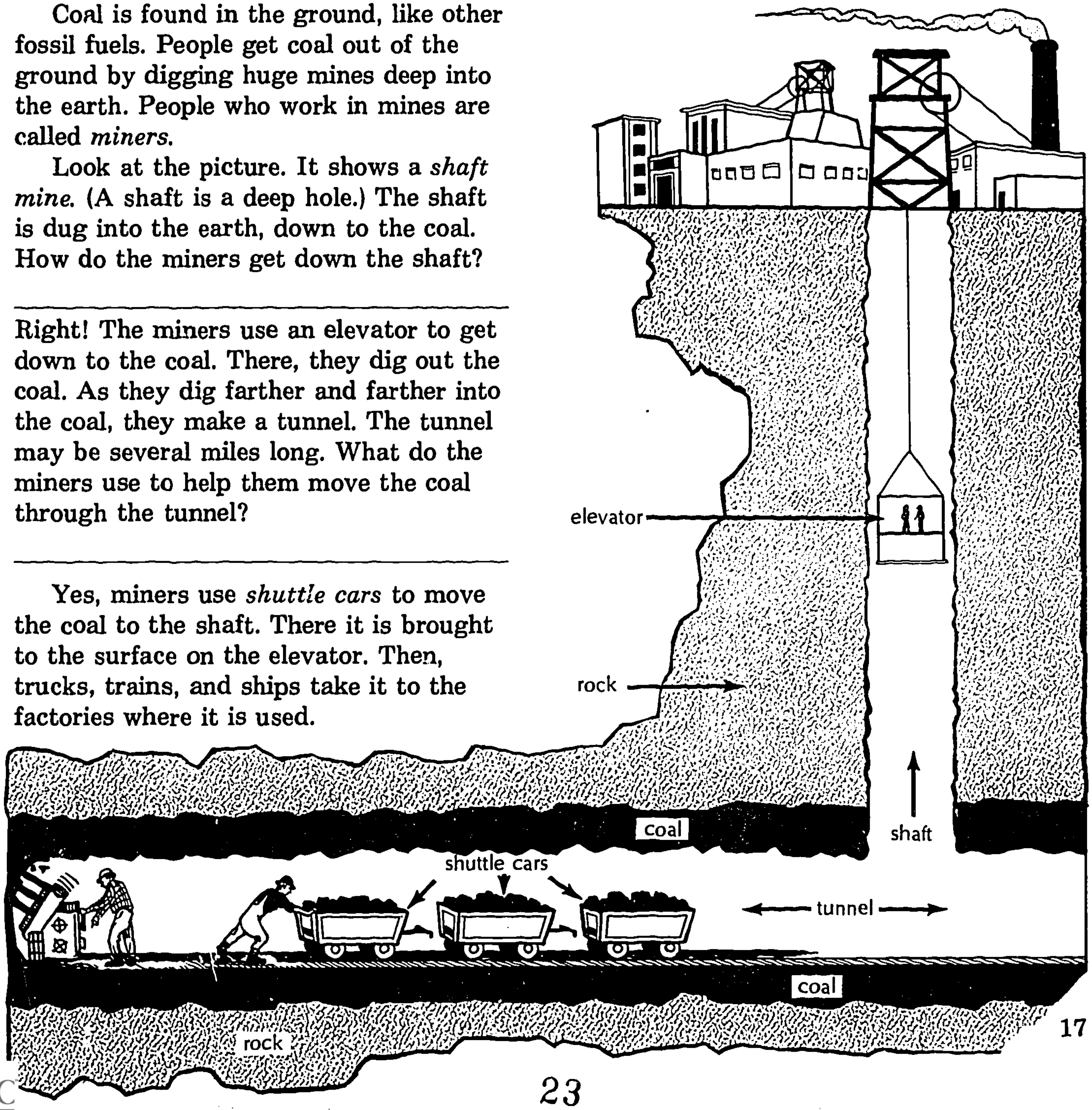
Once coal was used mainly to run trains and heat houses. Today it is burned mostly in factories to make steel, cement, paper, and other things.

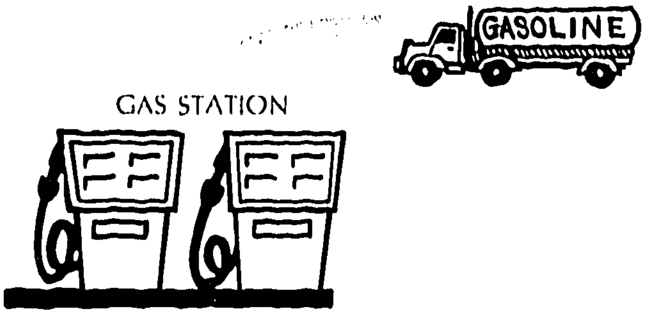
Coal is found in the ground, like other fossil fuels. People get coal out of the ground by digging huge mines deep into the earth. People who work in mines are called *miners*.

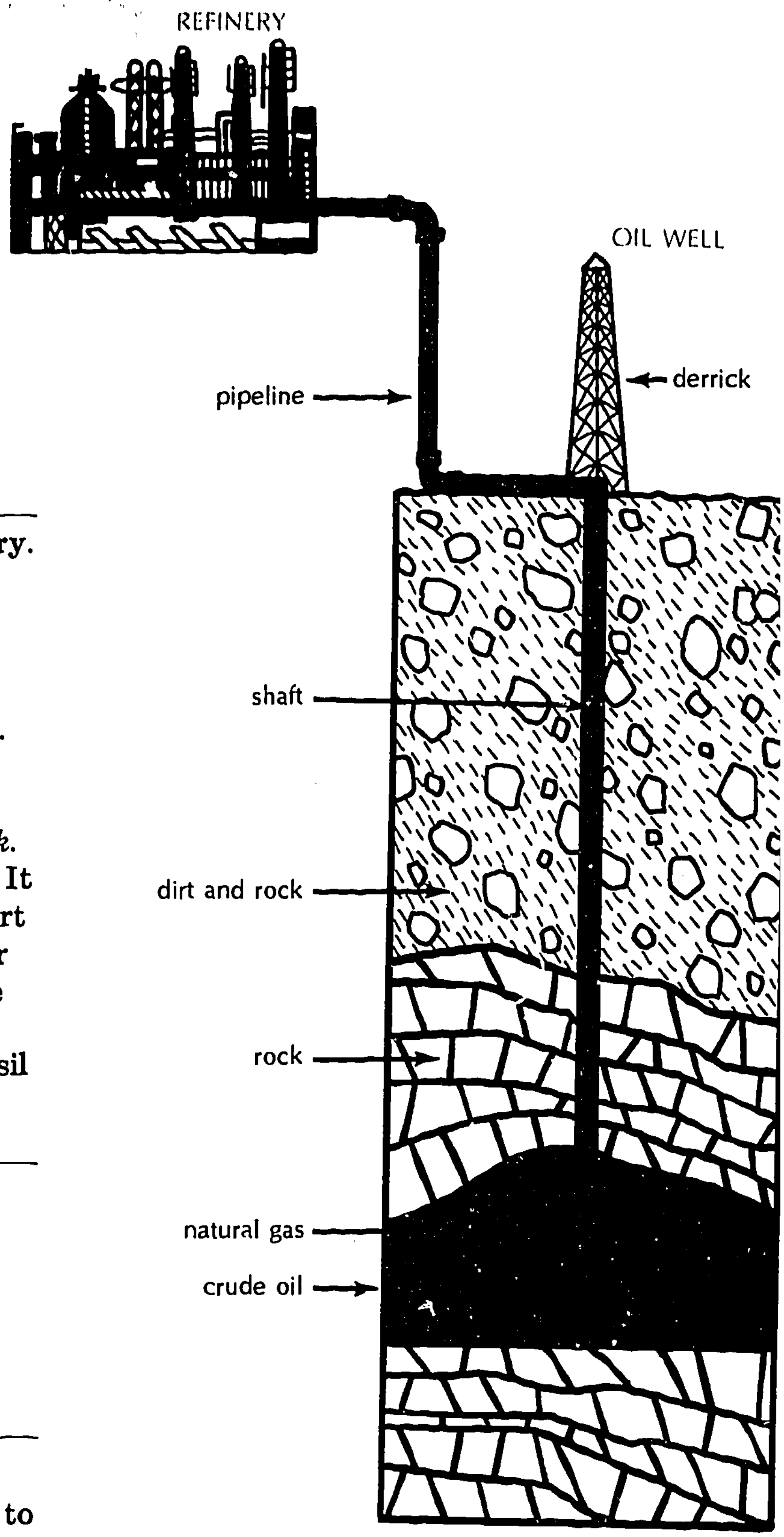
Look at the picture. It shows a *shaft mine*. (A shaft is a deep hole.) The shaft is dug into the earth, down to the coal. How do the miners get down the shaft?

Right! The miners use an elevator to get down to the coal. There, they dig out the coal. As they dig farther and farther into the coal, they make a tunnel. The tunnel may be several miles long. What do the miners use to help them move the coal through the tunnel?

Yes, miners use *shuttle cars* to move the coal to the shaft. There it is brought to the surface on the elevator. Then, trucks, trains, and ships take it to the factories where it is used.







Fuel from Crude Oil

You go to a gas station to buy gasoline. Where do you think the gas station gets that gasoline?

___

Gas stations get gasoline from a **refinery**. A refinery is a factory that makes gasoline and other products from crude oil.

Crude oil is found deep under the ground. We use oil wells to get that oil. The picture at the right shows an oil well.

At the top of the oil well is a *derrick*. A derrick is a special digging machine. It has a long drill that can dig through dirt and rock. As it digs, it makes a hole (or shaft). When the drill reaches the crude oil, the oil spurts up through the shaft.

Look at the picture. What other fossil fuel is found with the crude oil?

___

Right! Natural gas is usually found above the crude oil.

The natural gas and crude oil spurt up the shaft. At the top of the ground, they go into a long pipe. What is that pipe?

___

Gas and crude oil from the shaft go into the *pipeline*. It takes the crude oil to a refinery. There, some of the oil is turned into gasoline. How does the gasoline get to the gas station?

___

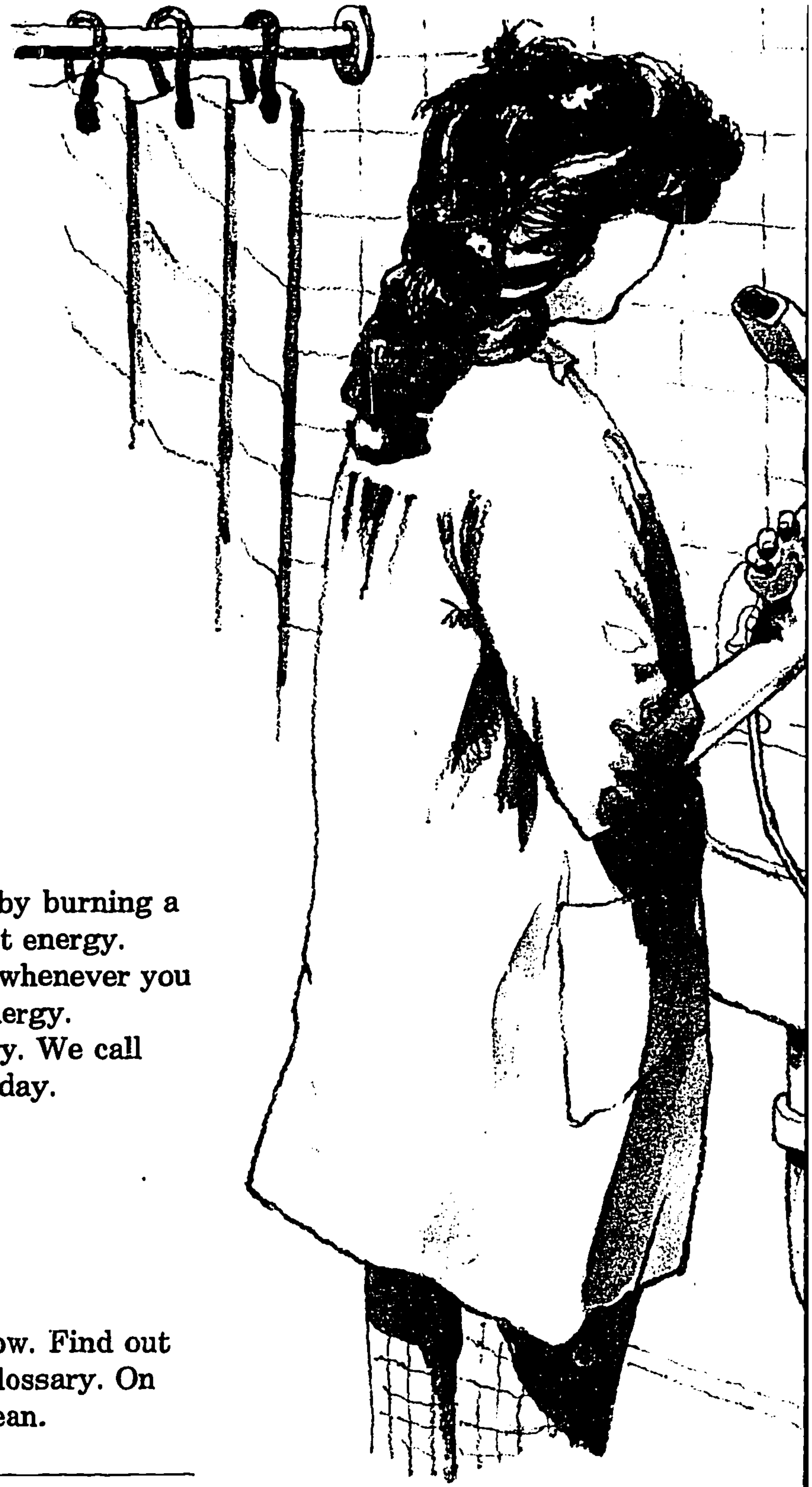
Check Yourself

Show what you learned in this unit. Finish these sentences. Draw a line from the words on the left to the correct words on the right. (The first one is done.)

1. Most of our energy	a. and natural gas out of the ground.
2. Some fossil fuels are	b. that lived millions of years ago.
3. Fossil fuels are the remains of things	c. comes from fossil fuels.
4. We get coal by	d. into gasoline and other products.
5. We use oil wells to get oil	e. coal, oil, and natural gas.
6. Refineries turn crude oil	f. mining it out of the ground.

Check These Out

1. Have you seen a movie or TV show about working in a coal mine? Tell the class about it. What are some problems that miners have?
2. The United States has a lot of coal under its surface. Find out where. Draw a map showing the states that have coal.
3. Find out the main places in the world where crude oil is found. Get a map of the world. Mark those places on that map with pins or stickers.
4. Is a refinery, oil well, or coal mine in your area? Visit it with your class.
5. Crude oil is sometimes called *petroleum*. We make fuels and many other useful things from petroleum. What are those other useful things?
6. Many science museums have exhibits about fossil fuels. Visit one of those museums.
7. Here are more things you may want to find out:
   - Strip mining is another way of getting coal out of the ground. What is a strip mine like? How is it different from a shaft mine?
   - Oil is sometimes found under the ocean floor. How is that oil brought to the surface of the ocean?
   - How do refineries make gasoline from crude oil?
   - What other kinds of fuel are made from crude oil?
   - What happens to the natural gas that comes up through the shaft? How is it used? How does it get to a person's house?



Unit 4

Electricity

You learned that you can get energy by burning a fuel. But there's another way you can get energy. You can turn on a switch! For example, whenever you turn on a light switch you are getting energy.

The energy you use is electrical energy. We call that energy *electricity*. You use it every day.

- How is electricity used?
- How is electricity changed?
- How is electricity made?

You'll learn the answers in this unit.

Before You Start

You'll be using the science words below. Find out what they mean. Look them up in the Glossary. On the lines below, write what the words mean.

1. **appliance** ________________________________

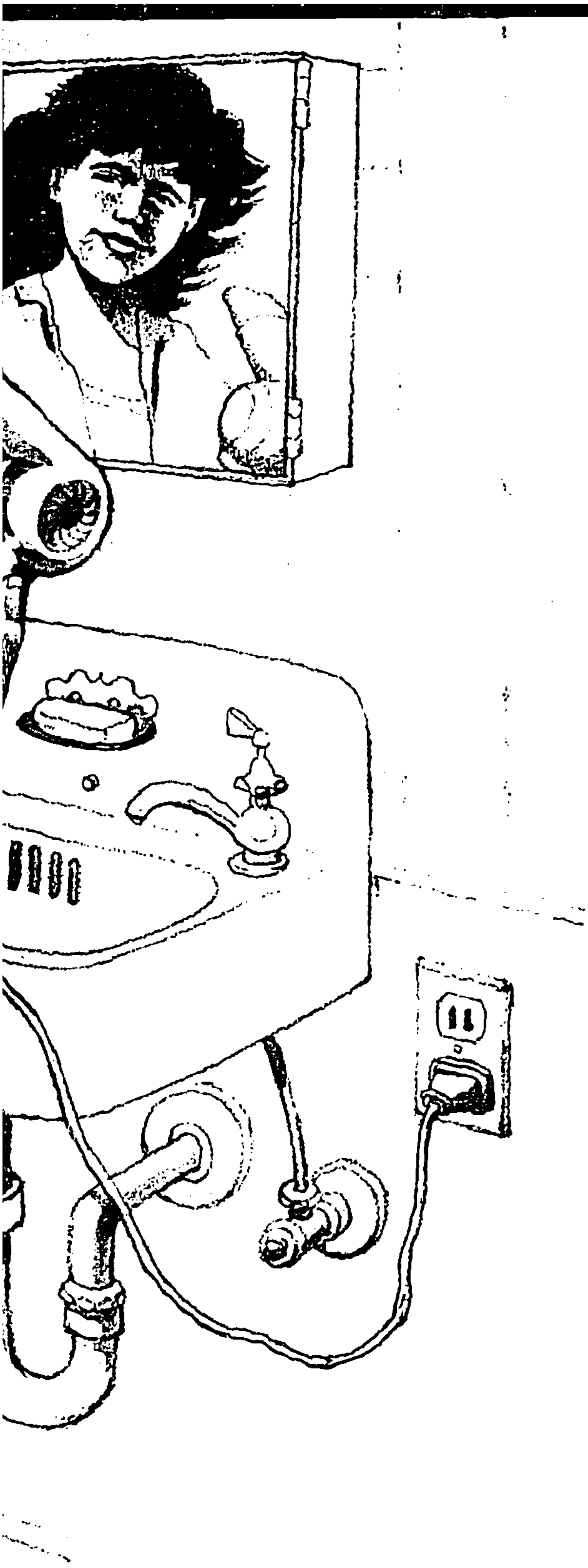
____

2. **magnet** ________________________________

____

3. **produce** ________________________________

____



Electrical Energy

You turn on a switch to light up a lamp. You turn on a switch to run a TV, or an electric heater. Things such as lamps, TV, and heaters are appliances. What do you think appliances do to electrical energy?

Right! They change electrical energy. They change it into heat, light, or motion energy.

When you turn on a light switch, electricity goes into a bulb. The bulb changes the electricity into light energy. Suppose you turn on a heater switch. What energy does the heater change electricity into?

Suppose you turn on a washing machine switch. What energy does the machine change electricity into?

Now think about different appliances in your home, school, or work.

1. What appliances change electricity into *heat*?

2. What appliances change electricity into *light*?

3. What appliances change electricity into *motion*?

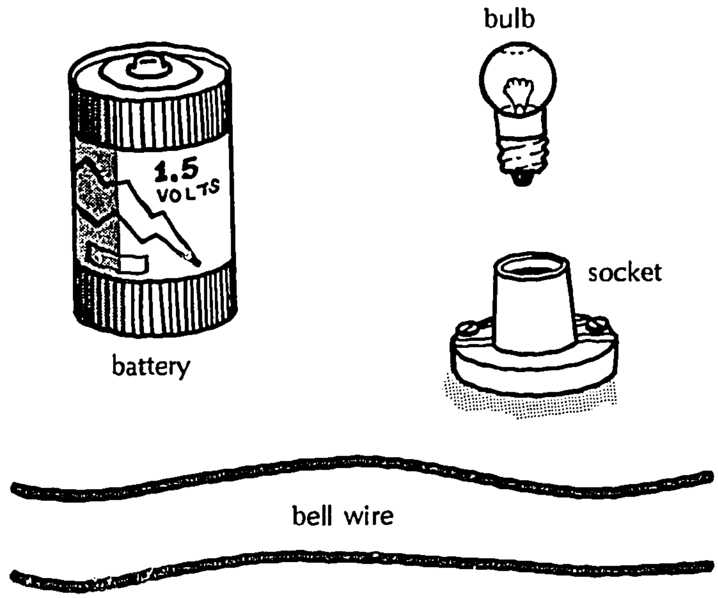
Electricity from a Battery

Turn on a switch — and you get electricity. But where does the electricity come from? It is *produced* by something.

One of the things that produces electricity is a battery. A battery has chemicals in it. It changes the energy of the chemicals into electricity.

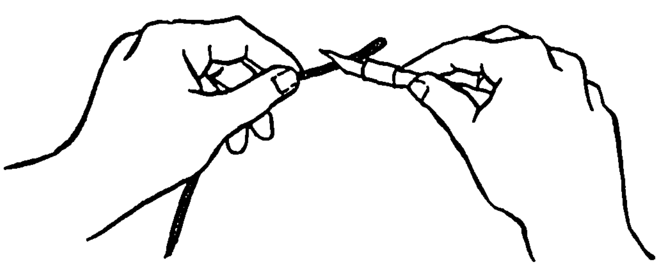
You can see how it works. You'll need:

- a flashlight battery (1.5 volts)
- a very small socket (with two posts)
- a flashlight bulb that fits the socket
- two bell wires, about 6 inches long

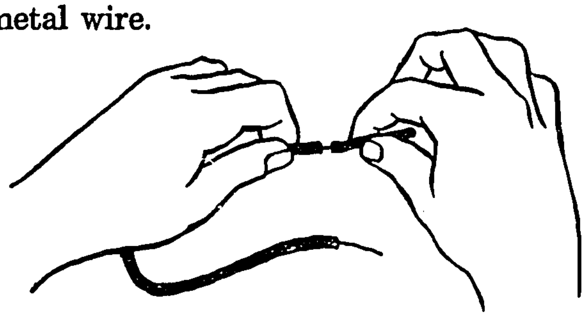


1

Strip the ends of each wire. First, carefully cut the covering one inch from the end. (Don't cut through the wire.) Cut all around the wire.



Pull the covering off the wire. You should now have an inch of metal wire.

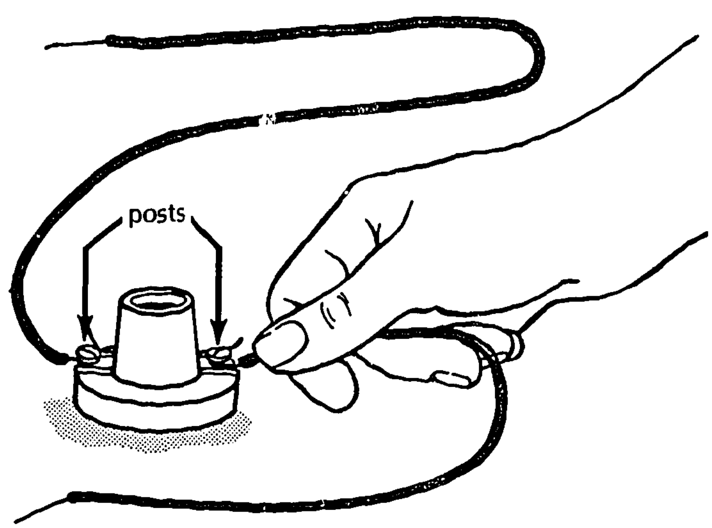


2

Get the socket.

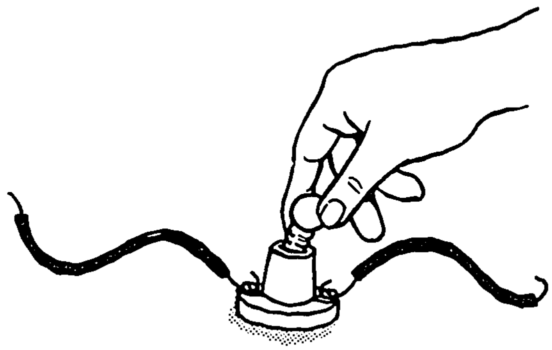
Connect the metal end of one wire to a post.

Connect the metal end of the other wire to the other post.



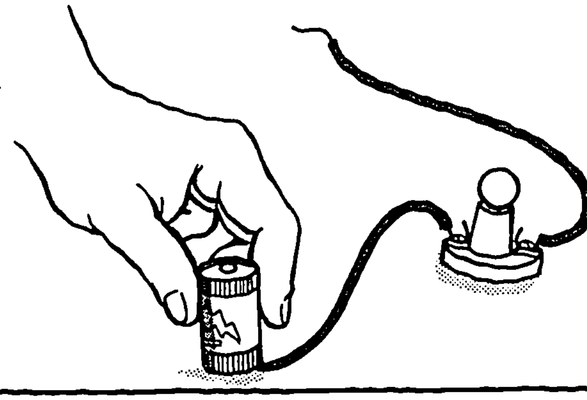
3

Put the bulb into the socket.



4

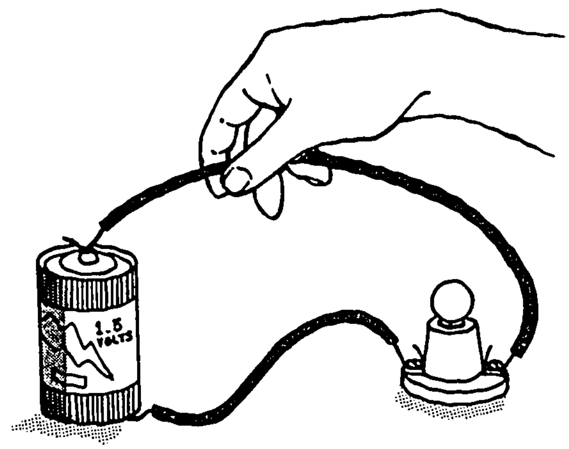
Put the battery on top of one of the wires. It should cover the metal end of the wire.



5

Pick up the other wire. Touch the top of the battery with it. Make sure the metal part of the wire touches the metal part of the battery.

Does the bulb light up? It should!



What Happens?

1. When does the bulb light up?

____

____

2. What energy makes the bulb light up?

____

____

3. Where does that energy come from?

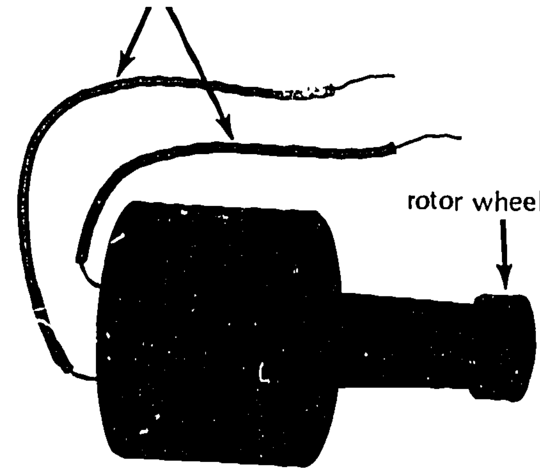
____

____

4. The bulb changes the energy from the battery into another kind of energy. What kind is it?

____

Electricity from a Generator



Bicycle generator

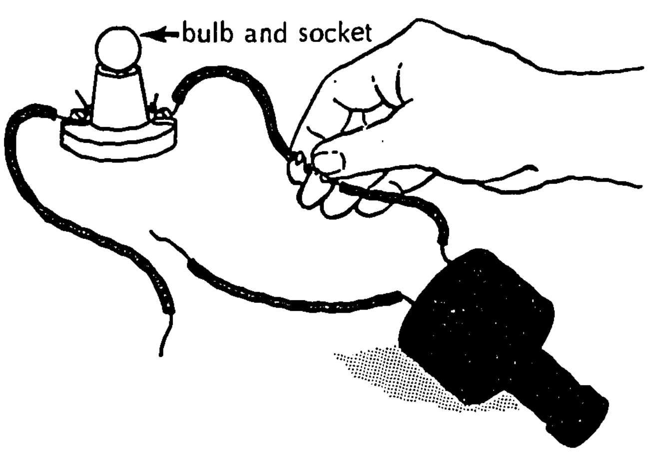
Another way to get electricity is this: Use a **generator**. A generator is a machine that produces electricity. It changes motion energy into electrical energy.

You can see how a generator uses motion energy to produce electricity. You'll need the bulb, wires, and socket you used before. Put them together the way you did for pages 22 and 23.

You'll also need a bicycle generator. (That's a small generator that fits on a bicycle. It lights up the bicycle headlight.) It should have two wires on it. It should also have a **rotor wheel** — a part that turns.

1

First join the wires on the generator to the wires on the socket. Twist the metal ends of the wires together.



2

Now twirl the rotor wheel as fast as you can. If you twirl fast enough, the bulb lights up.

What Happens?

1. The generator changes motion energy into electricity. What gives motion energy to the generator? (Hint: What turns the rotor wheel?)

____

2. Suppose the generator is on a bicycle. What do you think turns the rotor wheel?

____

Inside a Generator

What does a generator have inside of it? Look at the diagram. What parts are inside?

Right! A coil of wire and magnets are inside the generator.

Electricity can be made in several ways. You know of one way — with chemicals in a battery. Another way is with magnets. Magnets have a force called **magnetism**. When you put two magnets by each other, the magnetic force between them is very strong.

If a coil of wire moves through the magnetic force, this happens: Electricity is made in the wire. It flows through the wire.

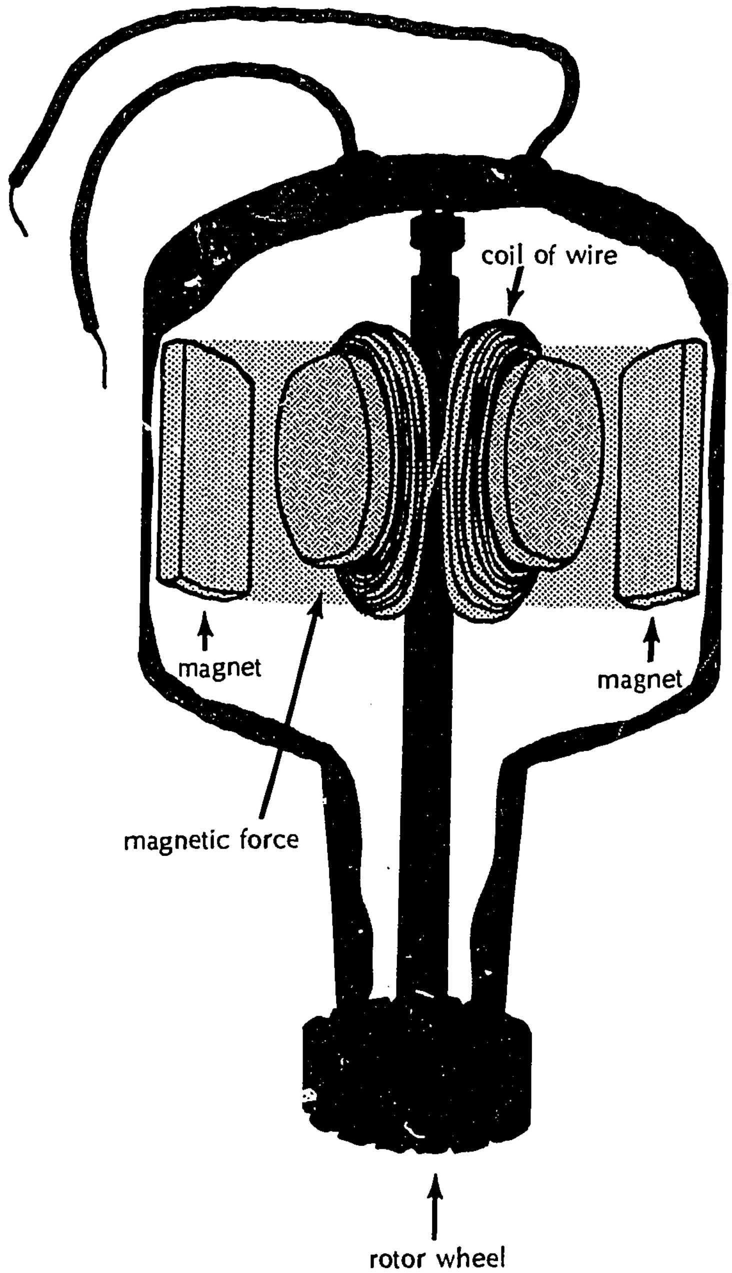
Look at the diagram again. The coil of wire is wrapped around a metal part. That part is joined to something that sticks out of the generator. What is it?

Yes! The metal part is joined to the rotor wheel.

What happens to the metal part when you turn the rotor wheel?

What then happens to the coil of wire?

Right! When you turn the rotor wheel, it turns the metal part. That moves the coil of wire. The wire moves through the magnetic force — and electricity is made!



Electricity from Running Water

Most of the electricity we use comes from **power plants**. Huge generators there make the electricity. Those generators are like the bicycle generator you learned about. But they are much bigger.

A generator in a power plant works the same way that a bicycle generator does: Something turns a rotor wheel. The rotor wheel then turns a part that has a coil of wire. The wire moves between magnets. And electricity is made.

The picture on this page shows a hydroelectric power plant. *Hydro* means "water." What do you think moves the rotor wheels in a hydroelectric power plant?

The diagram on this page shows how a hydroelectric plant works. The plant is close to a dam. The dam makes a big lake. It controls the water that flows from the lake.

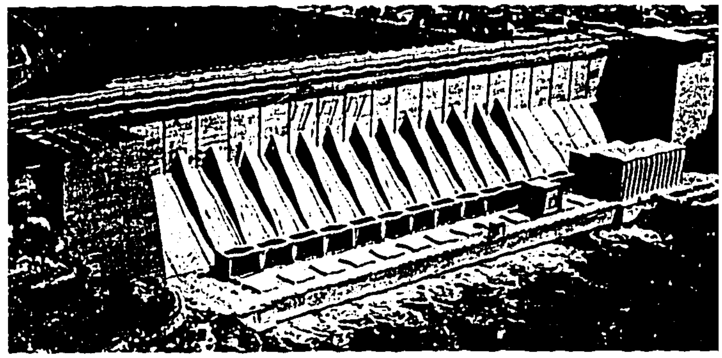
Some of the water goes through a big tube. The tube leads to the rotor wheel of a generator. The water has a lot of force. The water pushes the rotor wheel and turns it. The generator then makes electricity.

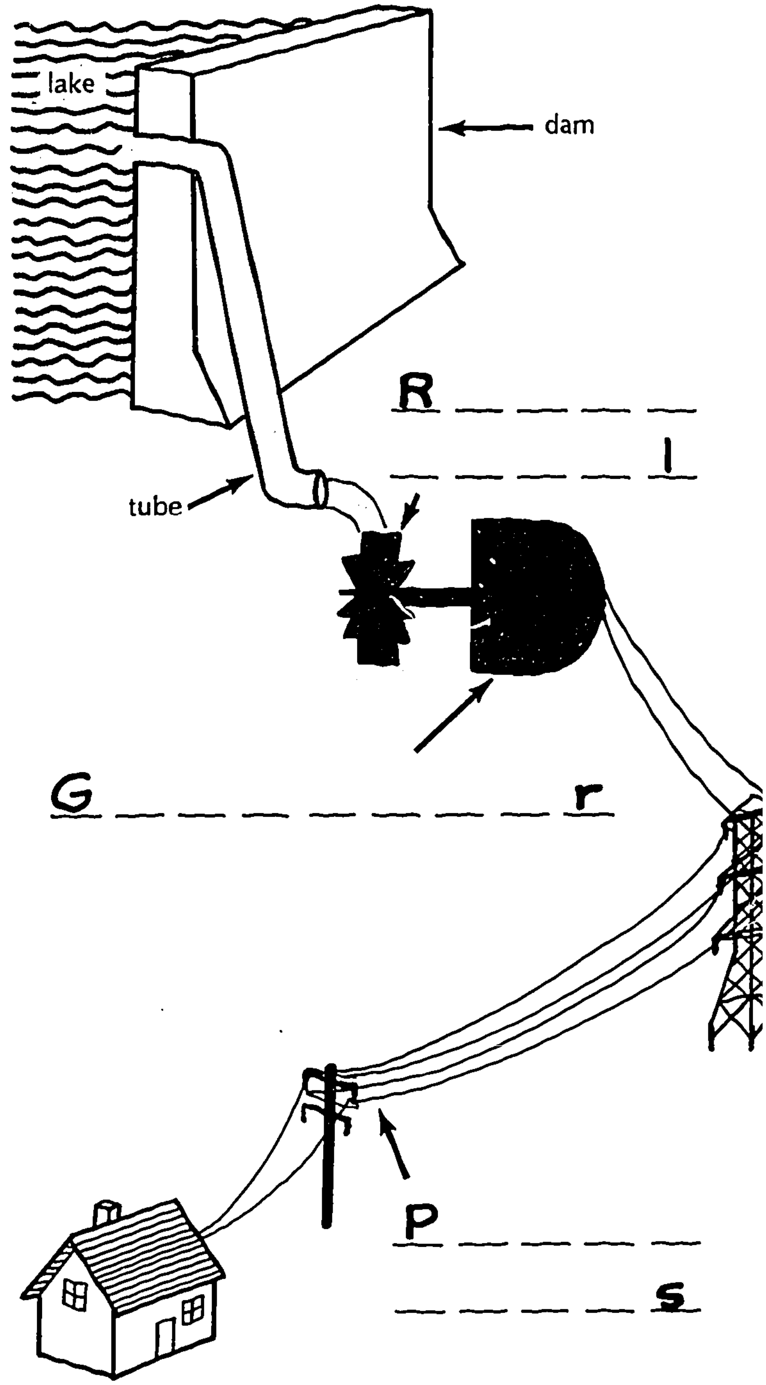
How does that electricity get to your house?

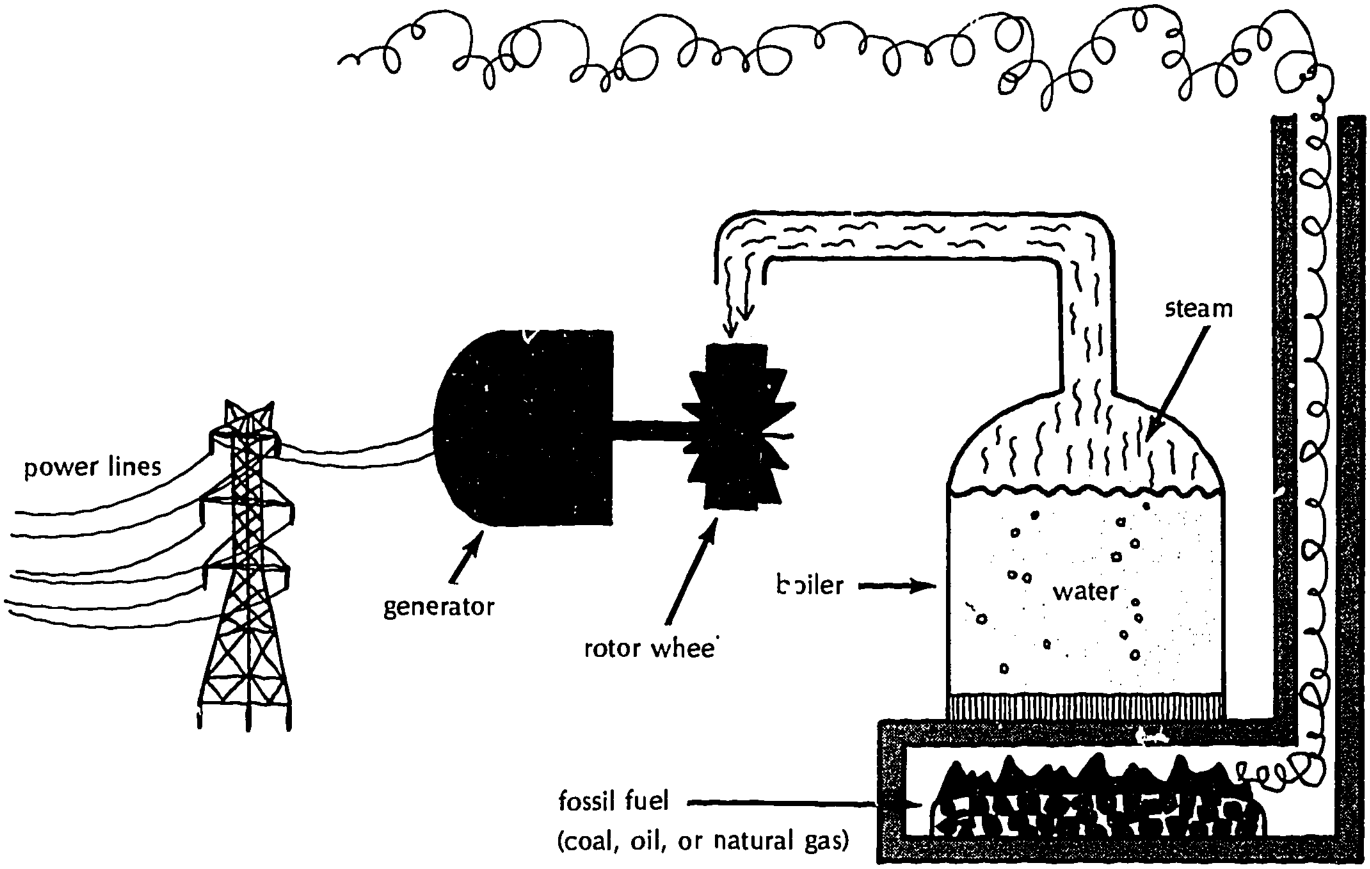
Right! Electricity travels from the power plant to your house through *power lines*.

On the diagram, write these labels where they belong: *rotor wheel, generator, power lines.*

New York Power Authority







Electricity from Steam

Picture this: You're boiling a pot of water. A cover is on the pot. The heat is turned up high. Suddenly, something pushes the cover up. What's pushing the cover?

____

Steam is pushing the cover.

Steam has a lot of *pressure.* Pressure is a kind of force that can move things. Steam can have enough pressure to move a rotor wheel. So, some power plants use steam to make electricity.

The diagram on this page shows how a power plant uses steam. A lot of water is first heated. Where is that water heated?

____

The water in the boiler is heated by a burning fuel. What kind of fuel is it?

____

When the water boils, it turns to steam. The steam goes through a pipe. The pipe leads to a rotor wheel. What happens next to make electricity?

____

____

____

____

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How does the electricity get to a person's house?

____

Meet Your Meter

The electricity that comes to your house is made by an electric company. You must pay the company for all the electricity you use. How does the electric company know how much electricity you use? It sends someone to read your meter.

A meter is something that measures the units (amounts) of electricity people use. A unit of electricity is called a *kilowatt-hour*.

The picture shows what an electric meter looks like. The meter has four dials. You read the meter by looking at each dial.

Look at the first dial. The hand in the dial points to 3. So, we read the first number as 3.

Look at the second dial. What number does the hand point to?

____

Right! It points to 1. So we read the second number as 1.

Look at the third dial. The hand is between two numbers. When that happens, we read the smaller number. What number is that?

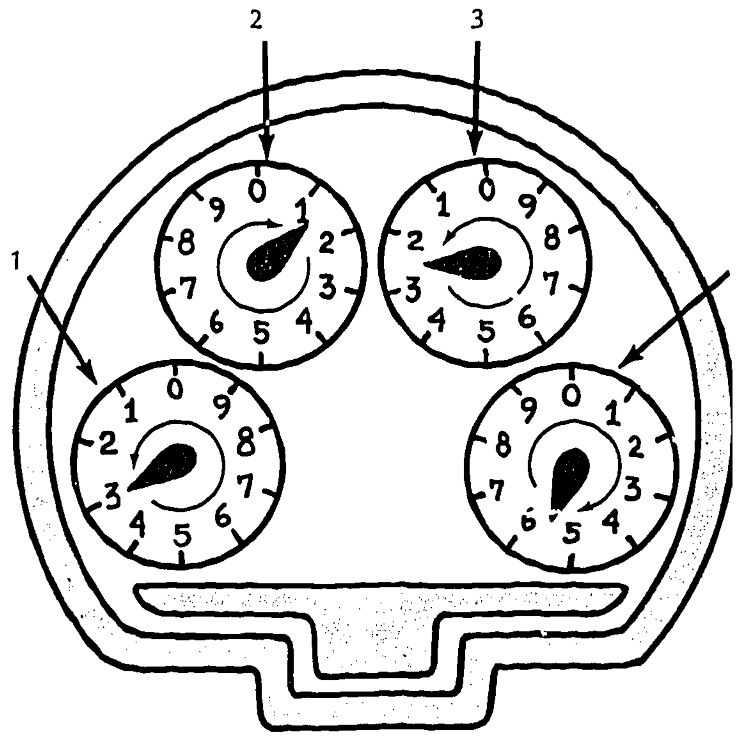
____

Right! The smaller number is 2. So we read the third number as 2.

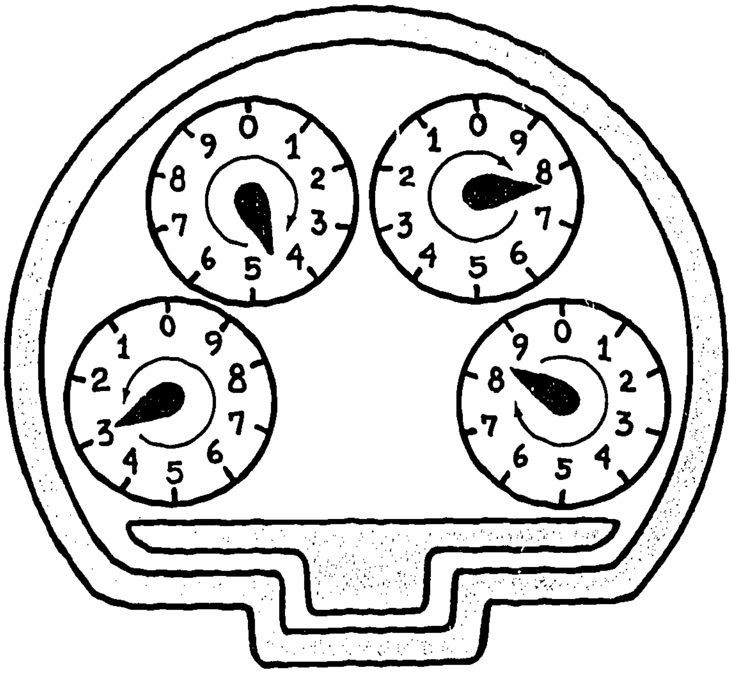
Look at the fourth dial. What number should we read?

____

Now read all four dials again. Write the kilowatt-hours below the picture. (The fourth number is done.)



___ ___ ___ 5 kilowatt-hours



___ ___ ___ ___ kilowatt-hours

□ □ □ □ this month
− □ □ □ □ last month
□ □ □ amount used

Answer

3478 this month
−3125 last month
353 amount used this month

How Much Electricity?

The electric company sends you a bill every month. The bill shows how much electricity you used during the month. And it shows how much money you owe.

Suppose the electric company wants to figure out how much electricity you used this month. This is what happens: It sends someone to read your meter at the end of the month. The number on the meter will be higher than it was last month. Why do you think that's so?

____

____

____

The meter keeps adding on the electricity you use. It adds it onto the last month's number. How does the company then figure out exactly what you used?

____

Right! It subtracts last month's number from this month's number.

Let's say the meter on this page shows the number for this month. And let's say the meter on the other page shows the number for last month. Read the meter for this month. Write the kilowatt-hours under the meter.

Now, figure out how much electricity you used. Write the number for this month on the top line at the left. Write the number for last month on the second line. Now, find the amount used: Subtract last month's number from this month's number. Then check your answer. (The right answer is upside down.)

Check Yourself

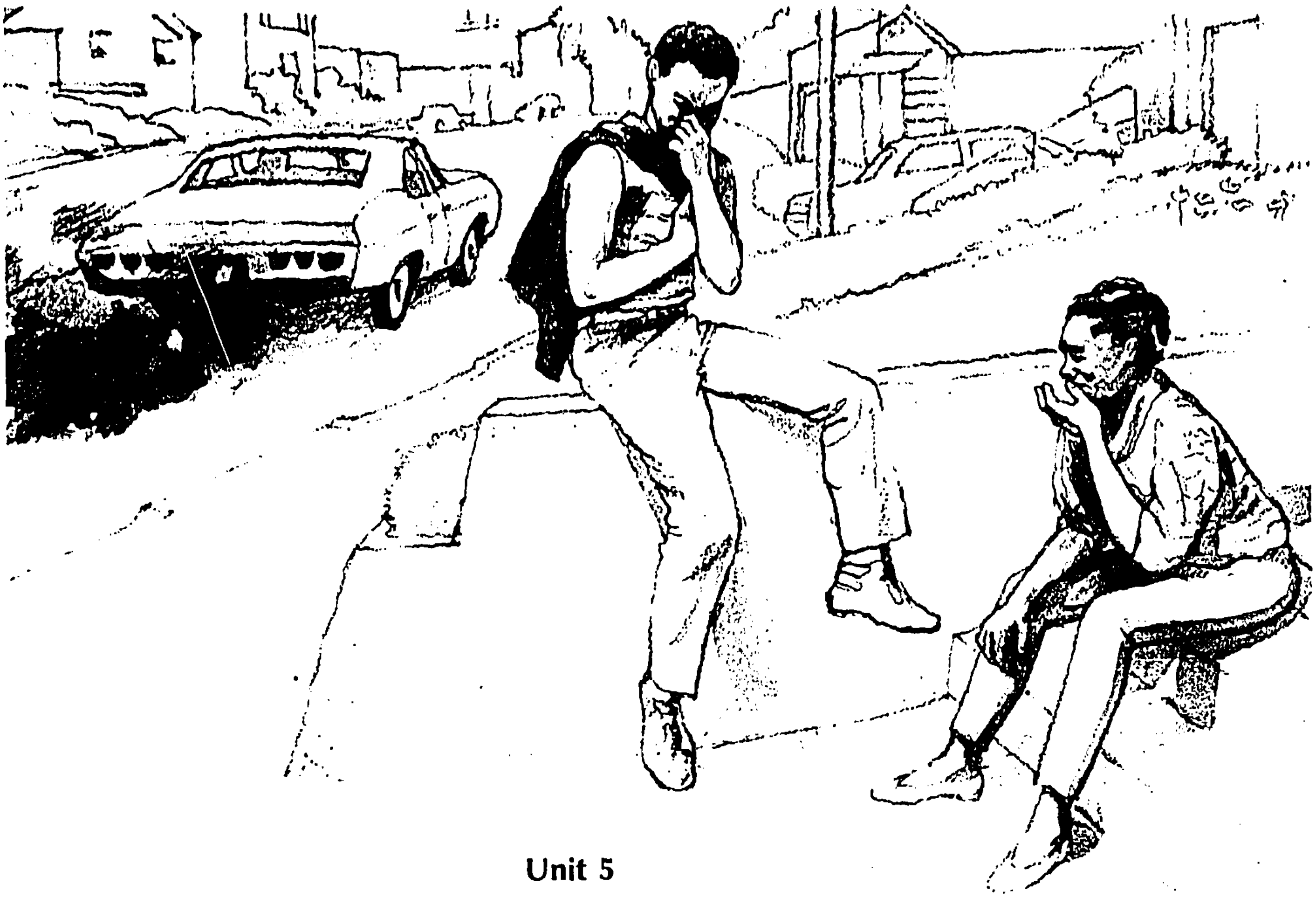
Show what you learned in this unit. Finish these sentences. Draw a line from the words on the left to the correct words on the right.

1. A battery makes electricity
2. A generator makes electricity
3. A rotor wheel moves
4. A hydroelectric power plant
5. Some power plants use steam
6. An electric meter measures

a. a coil of wire inside a generator.
b. with motion energy.
c. with chemical energy.
d. how much electricity you use.
e. gets motion energy from water.
f. to turn the rotor wheels.

Check These Out

1. Find the electric meter at your house, apartment, or school. Read the meter two days in a row. Subtract the first number from the second number. How many units of electricity were used?
2. Get a flashlight. Open it up. Find the batteries inside. Find the bulb. Draw a diagram to show how the batteries and bulb work together.
3. Invite someone from the electric company to talk to your class. Ask that person about how electricity is made in your area.
4. Bring different kinds of magnets to class. Find out what they do.
5. Ask a car mechanic to show you a generator in a car. Ask that person to explain what it makes electricity for. Find out what turns the rotor wheel.
6. Bring an electric bill to class. Learn how to read it. How much does one unit of electricity cost? What different things does the bill show?
7. Here are some things you may want to find out:
   - Sound is a kind of energy. How does a stereo turn electrical energy into sound energy?
   - How does an electric motor work?
   - What is an electromagnet?
   - What is an electric circuit? How does it work?
   - What are electrons? What do they have to do with electricity?
   - How do magnets work?



Unit 5

Solving Energy Problems

We burn fossil fuels in our homes, cars, and factories. We also burn fossil fuels to make electricity. But burning fossil fuels causes problems.

- What are the problems with burning fossil fuels?
- What other ways can we get energy?
- How can we use less energy?

You will learn the answers in this unit.

Before You Start

You'll be using the science words below. Find out what they mean. Look them up in the Glossary. On the lines below, write what the words mean.

1. **exhaust** ______________________________

____

2. **pollute** ______________________________

____

3. **radioactive** ______________________________

____

Too Much Smoke!

Think about a car that someone is starting up. Smoke pours out of the car's exhaust pipe. What is happening in the engine to make the smoke?

Gasoline is burning inside the engine. As it burns, it produces smoke. The smoke comes out of the exhaust pipe. That smoke has different gases in it. It is also full of tiny bits of material.

Thousands of cars are driven every day. They all send out smoke. Thousands of factories and homes burn fossil fuels. They send out smoke too. Cars, factories, homes — all those make a lot of smoke. Where does the smoke go?

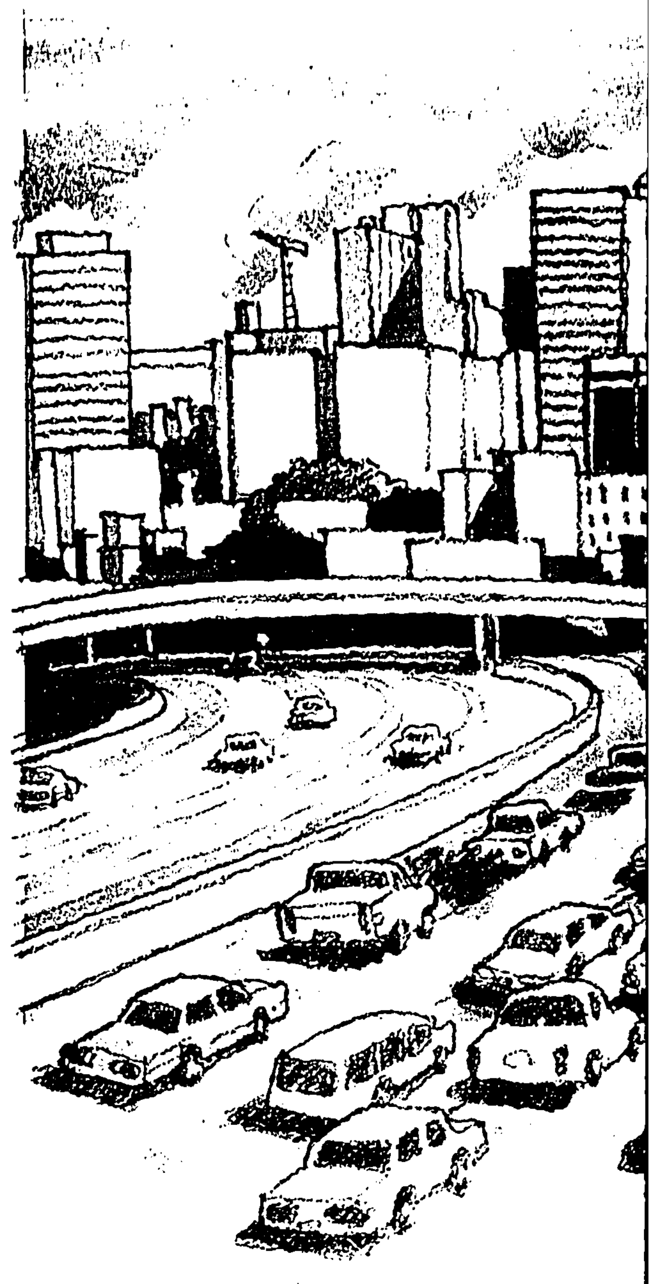
It goes into the air. We *breathe* that air.

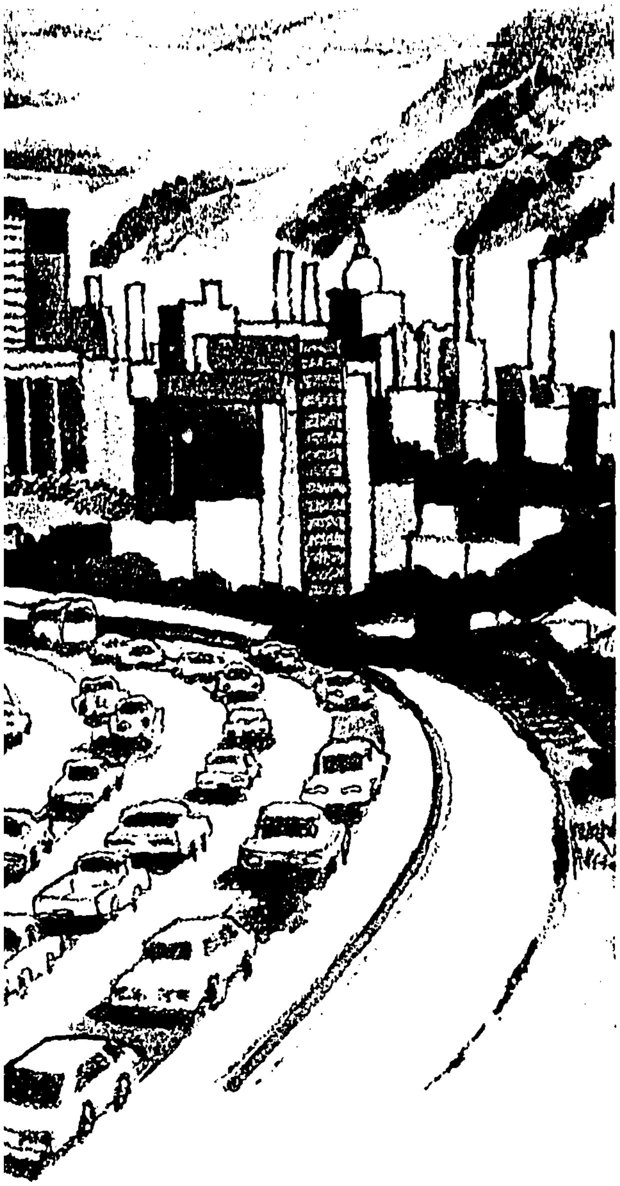
Fossil fuels give off lots of smoke and gases while they burn. So, burning too much fossil fuels can pollute our air. For example, *smog* is made from smoke and other exhaust gases that come from cars, factories, and homes. Smog is a kind of air pollution. From far away it looks like a heavy layer of "dirty" yellow or brown air.

What's bad about polluted air?

Yes: Polluted air can make people sick. If people breathe too much polluted air, it can hurt their eyes, throat, and lungs. It can even kill people who have breathing problems. Polluted air also harms trees, farm crops, and animals.

We can cut down the amount of pollution that goes into our air. How do you think we can do that?





Digging Deeper!

Air pollution is just one problem with fossil fuels. Here's another problem: Fossil fuels near the surface of the Earth are being used up. They are becoming harder to get.

Oil and coal companies must dig deeper into the ground to find fossil fuels. They must spend more money on workers and machines. So digging up fossil fuels has become expensive for those companies. How do you think that affects you?

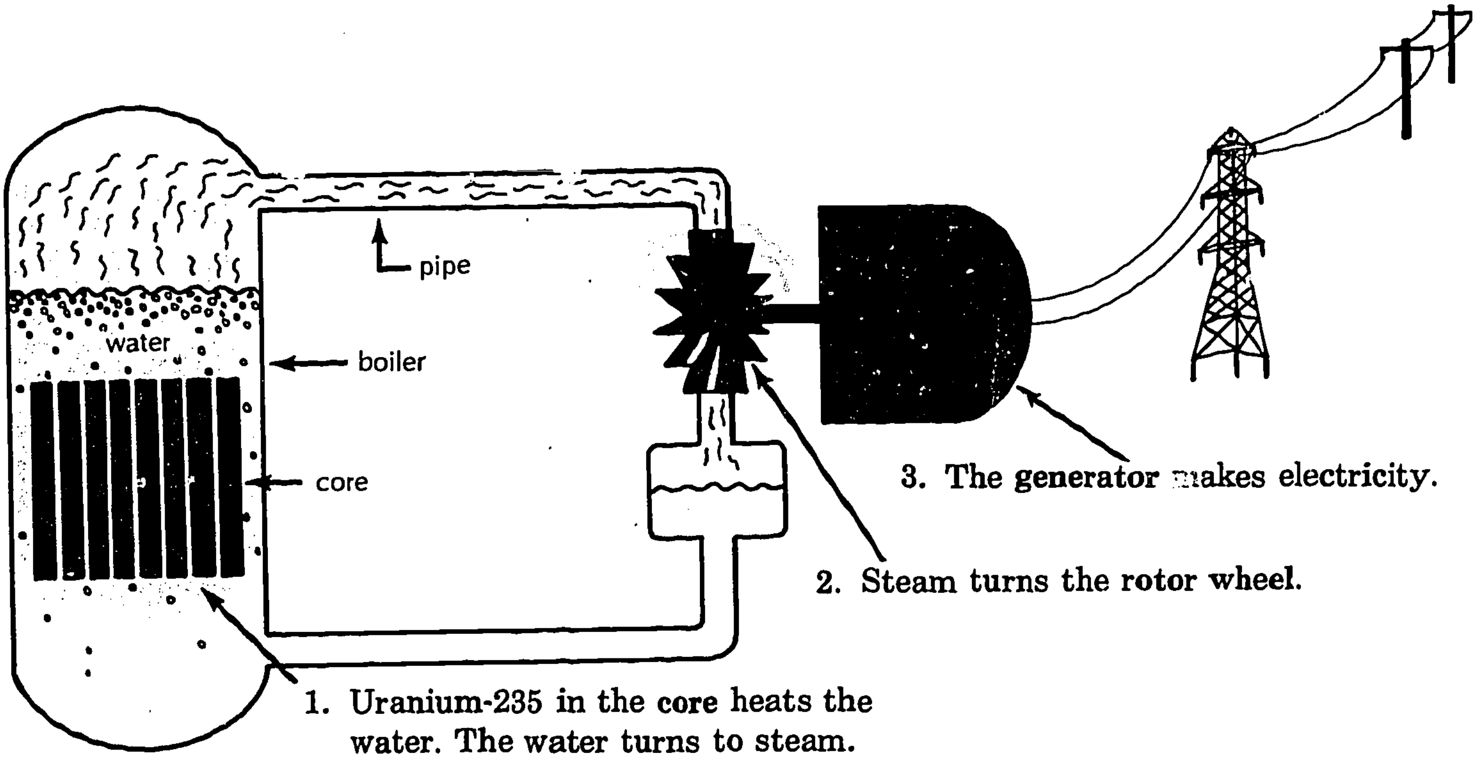
Right! You have to pay more to use the products of fossil fuels.

Everything that comes from fossil fuels is becoming expensive. As fossil fuels become harder and harder to get, their prices go higher and higher. What are some things that will cost you more?

You will have to pay more for gasoline to run your car. Your gas and electric bills will be higher. White gas, kerosene, and all other products from fossil fuels will become expensive.

Some day it may be too hard and expensive to get fossil fuels. People won't want to dig for them. It will be the same as running out of fossil fuels!

So people are starting to use other ways to get energy. What are some ways to get energy *without* using fossil fuels?



Nuclear Energy

Many power plants burn fossil fuels to make electricity. But some power plants are now using **nuclear fuel**.

Nuclear fuel is made from a special rock called **uranium-235.** Uranium-235 can release a lot of heat energy. It doesn't have to burn to give heat. So it doesn't make smoke.

Look at the diagram on this page. It shows how a nuclear power plant makes electricity.

1. The uranium-235 heats the water in the boiler. The uranium is in a special part. What is that part?

   __ __ __ __

2. Steam goes through a pipe and turns a part. What is that part?

   __ __ __ __ __   __ __ __ __ __

3. What then makes electricity?

   __ __ __ __ __ __ __ __ __

Uranium-235 does not pollute our air with smoke. But it can cause other problems. It is *radioactive.* It turns into waste materials that are also radioactive. Radioactive materials can cause cancer in living things.

People may be harmed if radioactive materials are accidentally released. So nuclear power plants must be built very carefully. Waste materials must be put in special containers. Those containers must be moved very carefully and stored in safe places.

What problem might nuclear energy solve?

____

____

What problem might nuclear energy cause?

____

____

Wind Energy

Fossil fuels and nuclear energy cause problems. So, people look for sources of energy that are cheap and *clean*. (Clean energy doesn't pollute.)

One source of energy that is cheap and clean is the wind. Wind power has been used for thousands of years. What is one way people have used the wind to move things on water?

For thousands of years, people have used the wind to sail ships. They used wind energy to get motion energy.

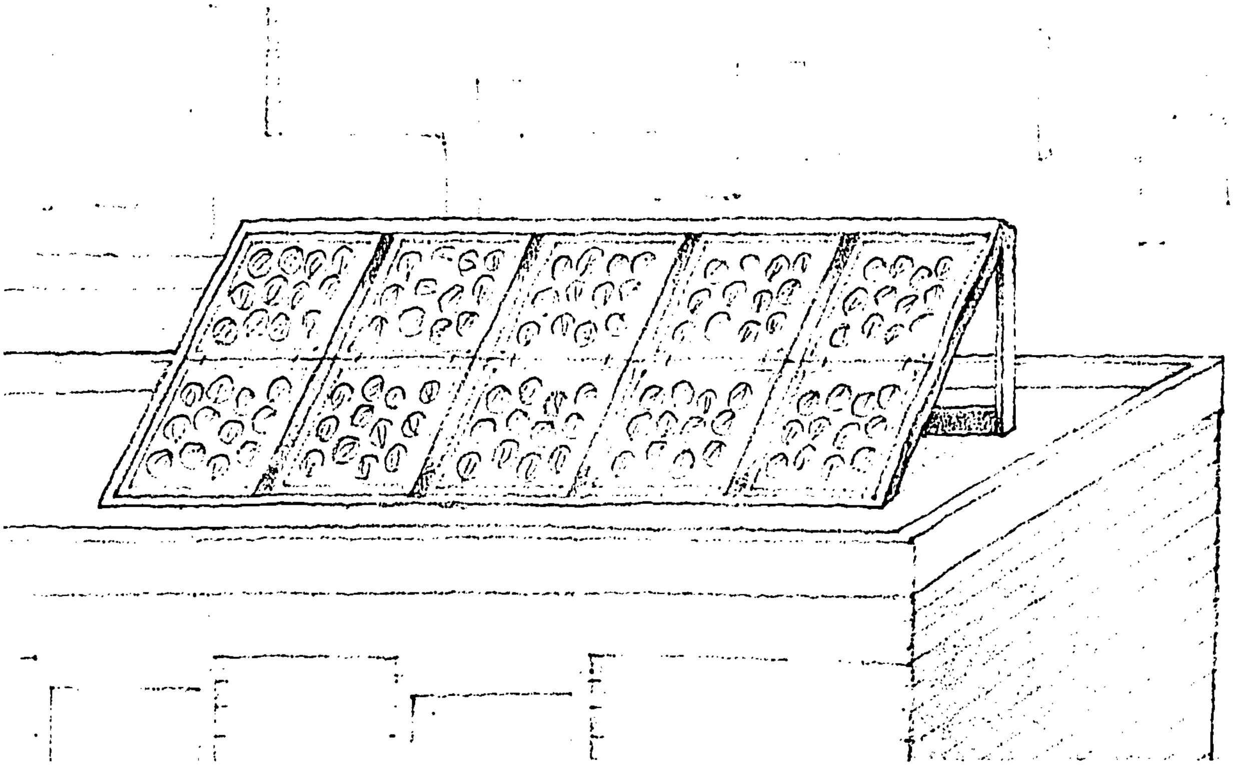
People are now using wind energy to get electrical energy. Look at the picture on this page. It shows a special kind of windmill that makes electricity. The windmill has a generator and a rotor wheel. It is called a **wind generator.** How do you think it works?

Dick Peboody, U.S. Department of Energy

When the wind blows, it turns the rotor wheel. As the rotor wheel turns, the generator makes electricity. The rotor wheel is shaped like an airplane propeller so it will turn easily in the wind.

Wind generators have one big problem. What do you think it is?

The wind does not always blow. The generator can't make electricity on those days. It makes electricity only on windy days. So some of the electricity that the wind generator makes is stored. It is stored in big batteries that are used on days when there is no wind.



solar cells

Electricity from the Sun

Heat energy can be changed into electricity. So can motion energy. What's a third kind of energy that can be changed into electricity?

____

Light energy can also be changed into electricity. We get that light energy from the sun.

People use **solar cells** to get electricity from sunlight. Solar cells are made from a special material called **silicon.** The silicon is cut into flat, round pieces. The pieces are the size of a small dish. Each side of the silicon is coated with a different chemical. A wire is connected to each side of the solar cell. When the sun shines on the silicon, electricity flows through the wire.

One solar cell doesn't produce enough electricity. So several solar cells are connected. Together, they make enough electricity to run many appliances.

Solar energy, like wind energy, has a big problem. What do you think it is?

____

Right! The sun doesn't always shine. Solar cells can't make electricity at night or on cloudy days. So some of the electricity that's made on sunny days must be stored. It is stored in batteries to be used when there is no sunlight.

How do solar energy and wind energy help solve the problem of fossil fuels running out?

____

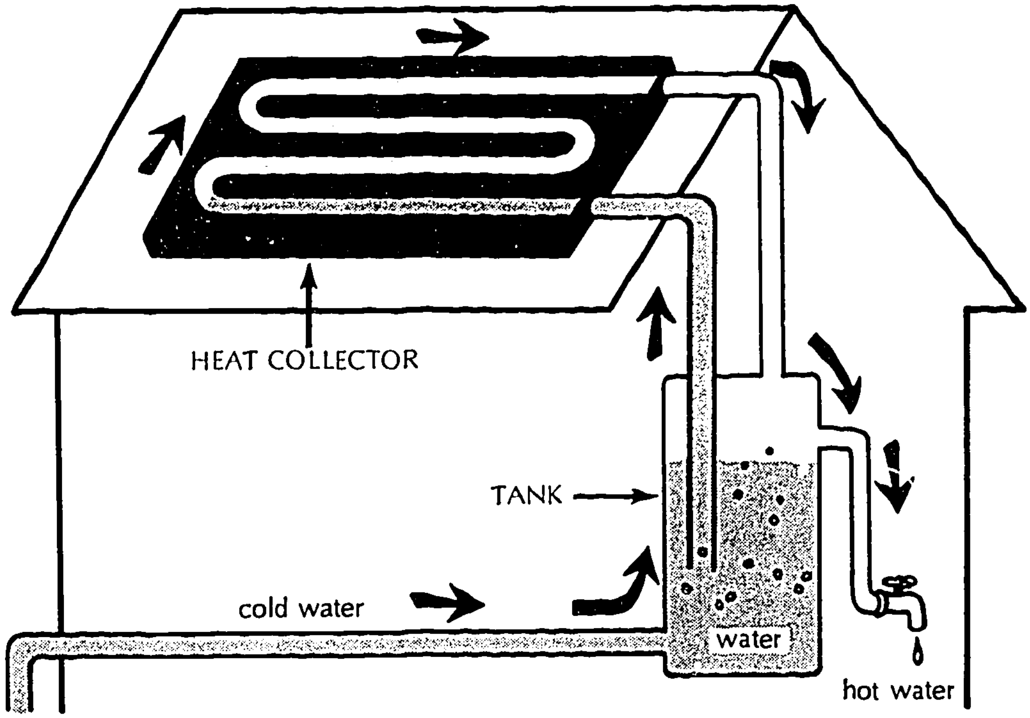
____

Right! The sun and wind will always be around. They are **renewable** sources of energy. They will never run out.

How do solar and wind energy help solve the problem of pollution?

____

____



Heat from the Sun

Here's another way to use the sun's energy: How is the water heated in your house, school, or place of work? Most people have water heaters that run on gas or electricity. But some people have *solar water heaters.* They use the sun to heat their water—and to save money.

Look at the diagram. It shows how a solar water heater works. The heater is on the roof of a building. One part of the heater is a large, flat piece of metal. What is the name of that flat metal part?

Yes, the flat metal part is a **heat collector.** It gets very warm when the sun shines on it.

The heat collector can get hot if it is painted a certain color. What do you think that color should be: black or white?

Things that are black get hot much faster than things that are white. (That is why black cars feel warmer than white cars when you touch them on a sunny day.) So, heat collectors are painted black.

Look at the diagram again. Notice the long pipe that's joined to the heat collector. That pipe is a water pipe. When water flows through the pipe, the water picks up heat from the heat collector. The hot water then flows to a part where it is stored. What part stores the hot water?

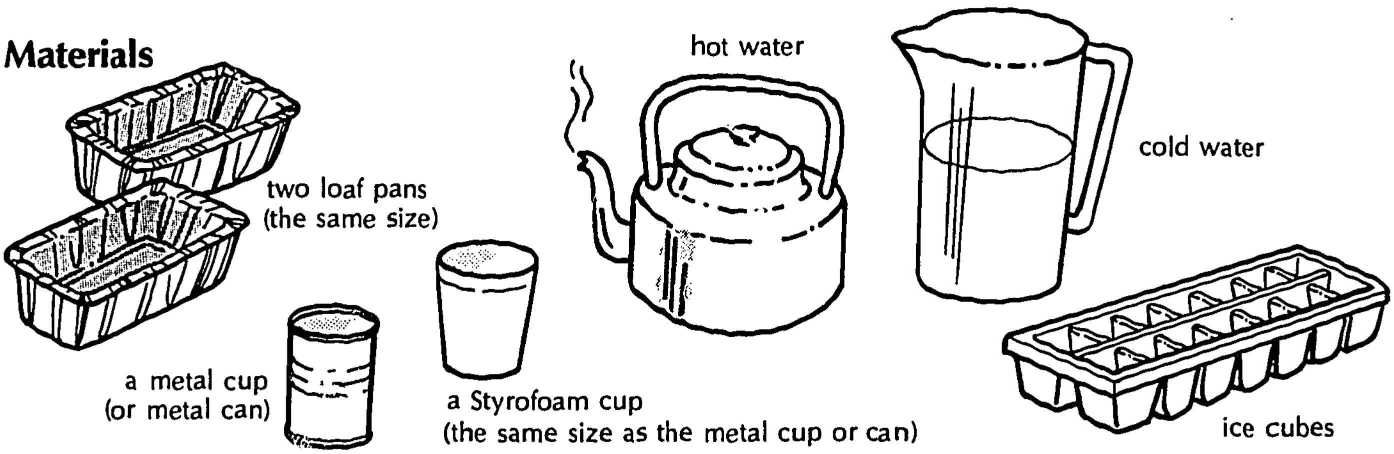
The tank stores the water that's heated by the sun. That water can get as hot as water heated by gas or electricity!

Experiment 2
Which material makes a good insulator?

One way to solve energy problems is to use less energy. For example: If we keep hot things from cooling off, we won't have to heat them up again. And we save energy.

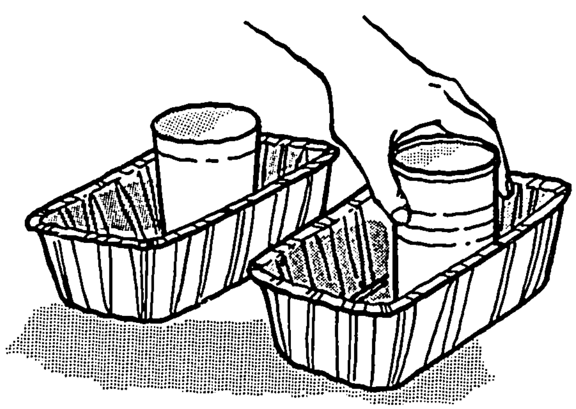
If you put hot things in certain materials, you can keep them from losing their heat. Those materials are called **insulators**. Does metal or Styrofoam make a good insulator?

Materials

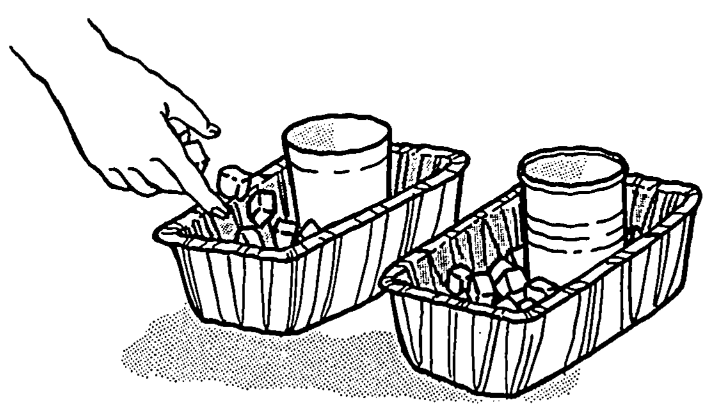


Procedure

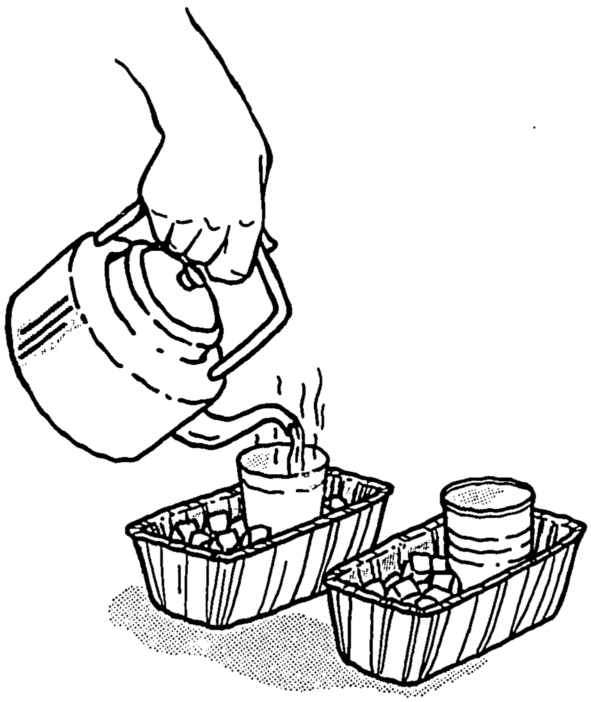
1. Place the Styrofoam cup in one loaf pan. Put the metal cup in the other loaf pan.



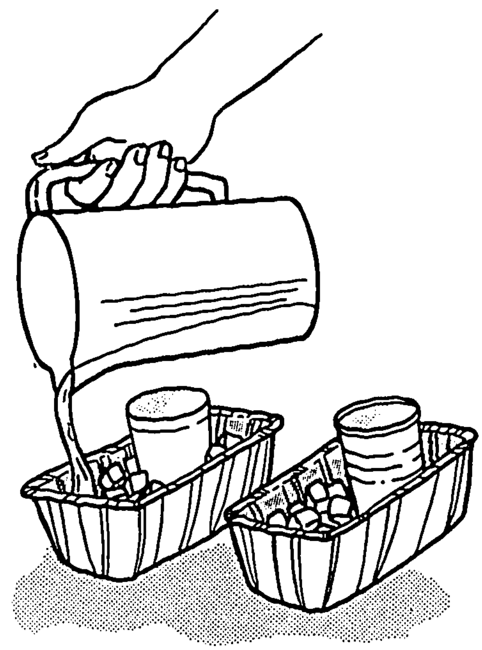
2. Put half the ice cubes in one pan. Put the other half in the other pan. (Do not put ice in the cups.)



3. Pour hot water into one cup. Pour the same amount of hot water into the other.



4. Fill both loaf pans with cold water. Wait about five minutes. Then touch the water in one cup. Next, touch the water in the other cup.



Observations

1. Is the water hotter in the Styrofoam cup or the metal cup.

____

2. Look at the ice cubes in the two pans. Did the ice melt faster around the Styrofoam or the metal cup?

____

Conclusions

1. Which material let out more heat: the metal or the Styrofoam?

____

2. Which material was better at keeping the hot water hot?

____

3. Which material makes a good insulator?

____

Check Yourself

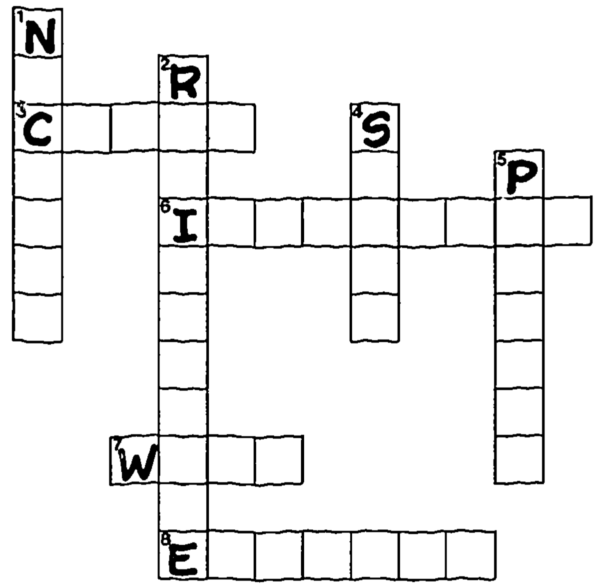
Use words from this unit to do the crossword puzzle. The clues below will help you. In the puzzle, each word is started for you. Check your spelling by looking at the page after each clue.

Across

3. A ____________ fuel doesn't dirty the air. (page 35)
6. A material that insulates. (page 38)
7. Energy from air that moves. (page 35)
8. Cars give off ____________ gases. (page 32)

Down

1. Energy from uranium-235. (page 34)
2. Uranium turns into ____________ wastes. (page 34)
4. Energy from the sun. (page 36)
5. To dirty something such as air. (page 32)



Check These Out

1. One way to use wind energy is with a sail. Make model sailboats that have sails of different sizes. What kind of sail moves the boat fastest?
2. Invite someone from an ecology group to come to your class. Ask that person how your community can solve energy problems.
3. Some calculators use solar cells instead of batteries. Borrow a solar calculator. What happens when you cover the solar cell?
4. Here are some more things you may want to find out:
   - Air pollution makes people sick in many ways. What are some of those ways?
   - How does uranium-235 become hot? Find out about *nuclear chain reactions.*
   - What are these other ways to get energy: *biomass, coal gasification, shale oil?*
   - What makes smog? What is *photochemical smog?* What's bad about smog? How can it be controlled?
   - What is *acid rain?* What causes it? What's bad about acid rain? How can it be controlled?
   - What is the *greenhouse effect?* What does burning fossil fuels have to do with it?

Unit 6

What Can You Do?

Most of the energy we use comes from fossil fuels. But fossil fuels cause problems! They pollute the air we breathe. And they are expensive: Our gas, electric, and fuel bills keep getting higher and higher.

What can we do about the problems of fossil fuels? We can **conserve** energy. That means we can use fossil fuels wisely. We can use them only when we need them and not waste them.

What things do you use that use fossil fuels? Make a list below of all the things you can think of.

1. Things that use gasoline or diesel fuel:

 ____

 ____

2. Things that use electricity:

 ____

 ____

 ____

 ____

3. Things that use natural gas:

 ____

 ____

4. Things that use kerosene or white gas:

 ____

 ____

Now look at all the things on your list. How can you conserve energy?

____

____

____

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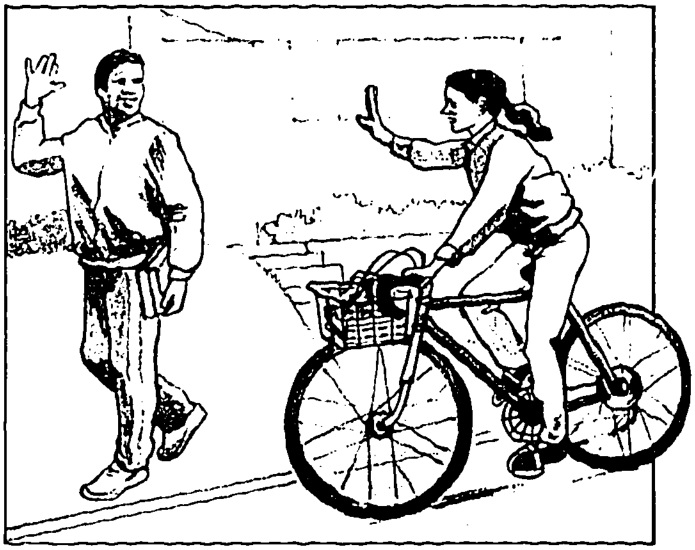
47

Save on Gasoline

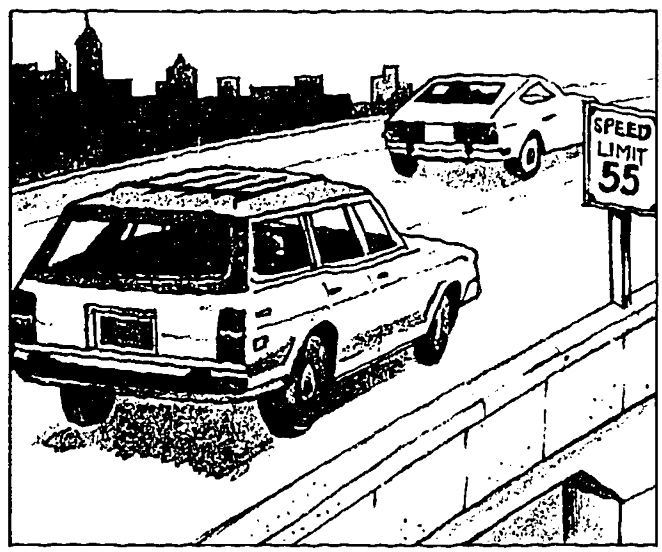
Here are some ways you can conserve gasoline and save money:



1. Walk or ride a bicycle instead of driving a car.

2. Take a bus or subway instead of driving a car.

3. Form a carpool. Ride with others to work or school. Use just one car.

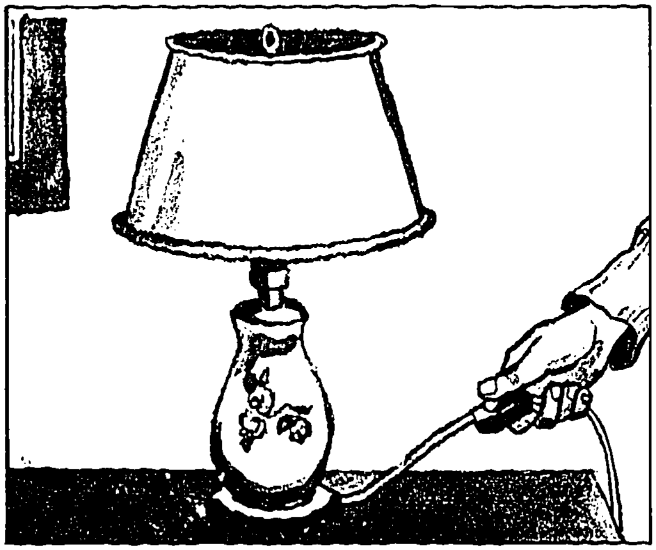


4. Never drive faster than 55 miles per hour!

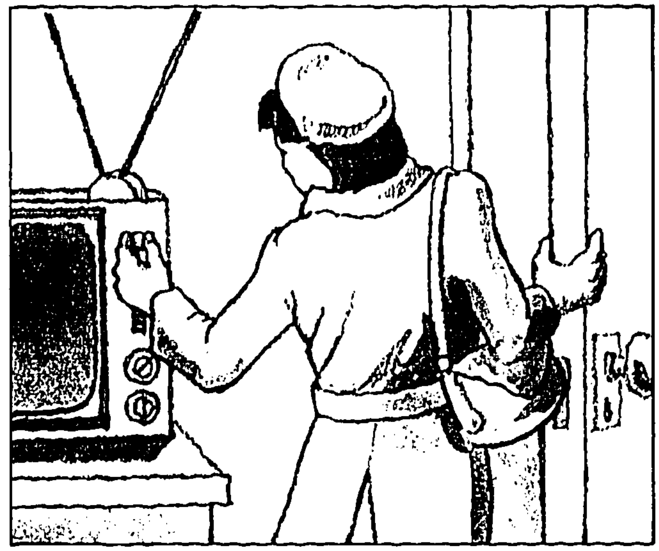
5. What other ways can you conserve gasoline?

Save on Electricity

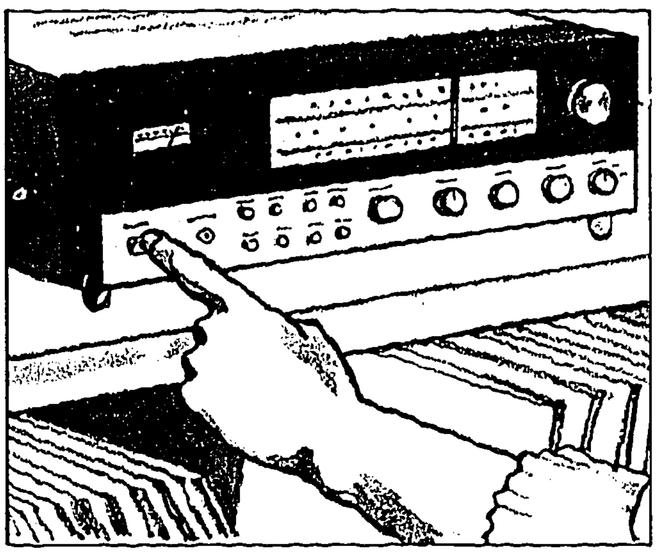
Here are some ways you can conserve electricity and save money:



1. Turn off lights when you leave a room.



2. Turn off the television when you are not watching it.



3. Turn off the stereo when you are not listening to it.

4. Don't use an appliance unless you really need to.

5. What else can you do to conserve electricity?

____

____

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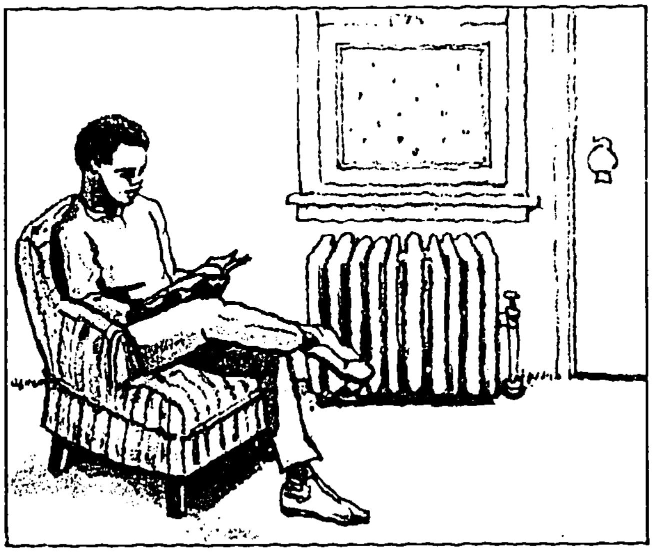
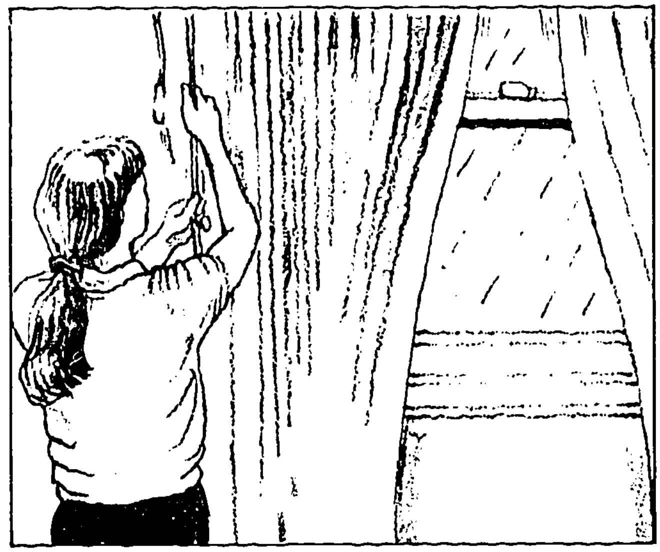
49

Save on Heat

Here are some ways you can conserve heat and save on your heating bill:

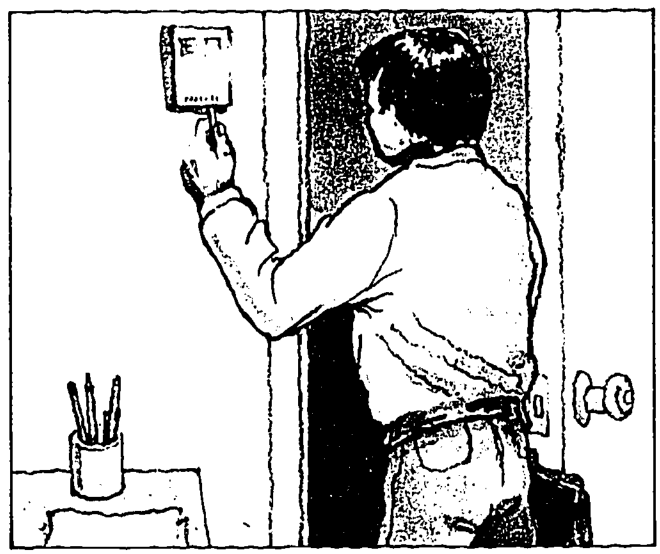


1. Keep the doors closed. This will keep the heat inside.



2. Keep the windows closed. Cover them with curtains or shades.

3. If you are cold, put on a sweater. Don't turn up the heat.



4. Turn off the heater when you won't be home.

5. What else can you do to save on your heating bill?

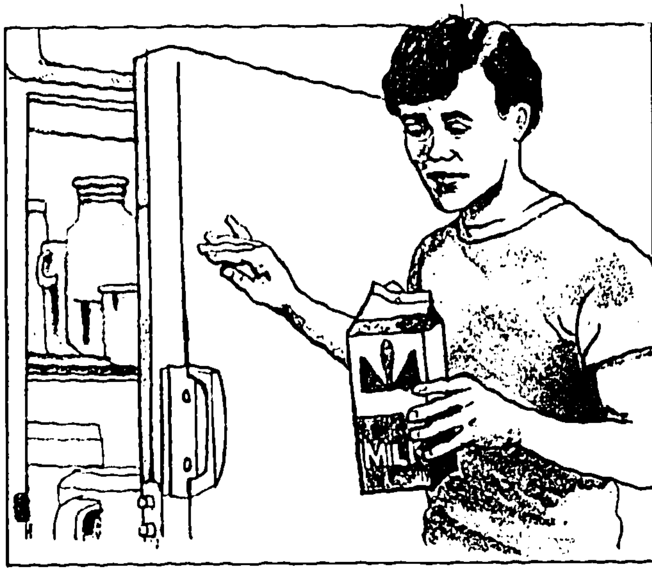
____

____

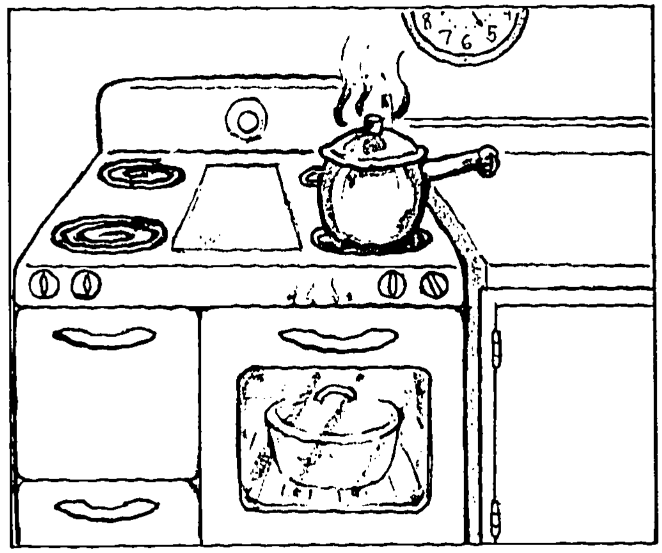
____

Save Energy at Home

Here are more ways you can save energy at home:

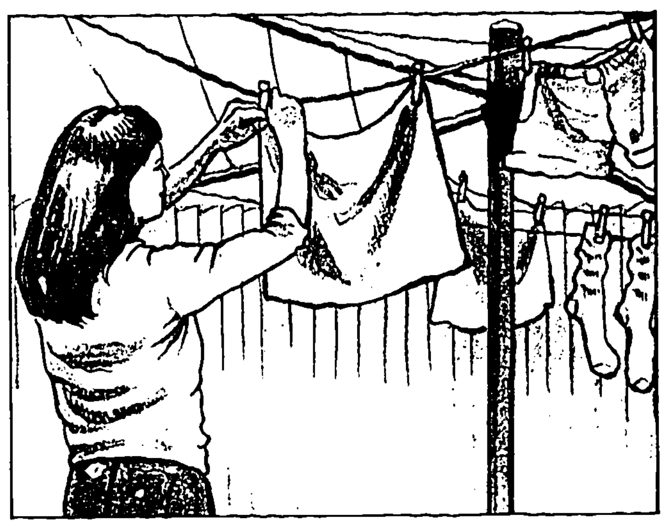


1. Keep the refrigerator door closed as much as you can.



2. When you are cooking, keep pots covered. Keep the oven door closed when the oven is on.

3. Run your dishwasher and clothes washer only when they are full.



4. Hang your clothes to dry, instead of using a dryer.

5. How else can you conserve energy at home?

____

____

____

Show What You Learned

What's the Answer?

Put an X in front of the right word or words. There may be more than one correct answer to a question.

1. What are kinds of energy?

   _____ a. Heat, light, motion.

   _____ b. Car, battery, grill.

   _____ c. Lamp, stove, radio.

2. What happens to potential energy?

   _____ a. It pollutes the air.

   _____ b. It is made.

   _____ c. It is changed to heat, light, and motion.

3. What changes the potential energy in fossil fuels to heat, light, and motion?

   _____ a. Mining.

   _____ b. Burning.

   _____ c. Conserving.

4. Which are used to make electricity?

   _____ a. Steam.

   _____ b. Running water.

   _____ c. Wind.

5. Where is electricity made?

   _____ a. In batteries and generators.

   _____ b. In solar cells and power plants.

   _____ c. In refineries and coal mines.

6. What sources of energy could run out?

   _____ a. Wind, water, solar.

   _____ b. Crude oil, natural gas.

   _____ c. Coal, nuclear.

What's the Word?

Write the correct word for each meaning.

1. Something we burn to get heat, light, or motion

   F ____________________

2. Energy that is stored

   P ____________________

3. A machine that makes electricity

   G ____________________

4. To make the air dirty

   P ____________________

5. Something that changes the sun's energy into electricity

   S __________ C __________

6. A material that keeps heat from leaving something

   I ____________________

7. To use energy wisely

   C ____________________

Congratulations!

You've learned a lot about energy. You've learned:

- what kinds of energy we use;
- how we get energy;
- how we can conserve energy; and
- many other important science facts about energy.

Glossary

ap pli ance Something that uses energy to give us heat, light, or motion.

clean en er gy Energy that does not make the air dirty.

coal A rock that is burned for energy.

con serve To use something wisely.

crude oil A thick black liquid that is burned for energy; petroleum.

en gine A machine that burns fuel and gives us energy.

ex haust Smoke that comes out of an engine.

fos sil The remains of a plant or animal that lived long ago.

fos sil fuels Materials we burn that are found under the ground.

fuel Material we burn for energy.

gen er a tor A machine that makes electricity.

heat col lec tor A thing that gets hot when the sun shines on it; a part of a solar water heater.

in su la tor A material that keeps heat from leaving quickly.

mag net A material that pulls on iron and steel.

mag ne tism The force that magnets have.

me ter A machine that measures how much electricity is used.

mine A place where rock such as coal is taken out of the ground.

mo tion What happens when something moves.

nat u ral gas A gas found underground that is burned for energy.

nu cle ar fuel A material that can give off heat without burning.

pol lute To make air, water, or land dirty.

po ten tial en er gy The energy that is held inside of things.

pow er plant A place that makes electricity for a community.

pro duce To make something.

prod ucts Things that are made.

ra di o ac tive Giving off dangerous rays or tiny bits of materials.

re fin er y A factory that makes gasoline and other things from crude oil.

re new a ble A source of energy that will not run out.

ro tor wheel A wheel that's turned in order to make electricity.

sil i con A material made from sand. Silicon is used to make solar cells.

so lar cell A thing that changes the sun's energy into electricity.

stored Kept inside of something.

u ra ni um-235 The material that's used as fuel for making nuclear energy.

wind gen er a tor A machine that makes electricity from wind energy.

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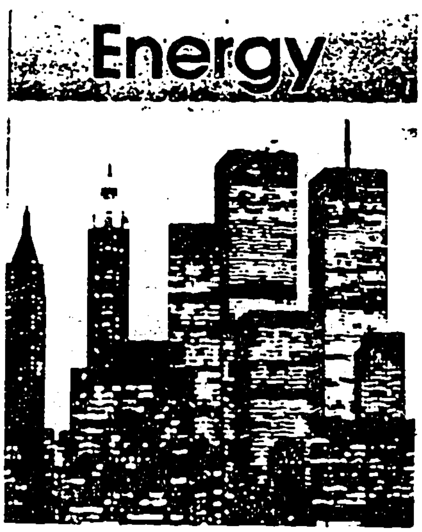

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