DOCUMENT RESUME

ED 186 281 SE 030 760

TITLE	How We Make Energy Work: Grades 4, 5, 6 Science.
INSTITUTION	National Science Teachers Association, Washington, D.C.
SPONS AGENCY	Department of Energy, Washington, D.C. Office of Consumer Affairs.
REPORT NO	DOE/CA/06083-02
PUB DATE	Apr 80
CONTRACT	EC-77-C-01-6083
NOTE	80p.
EDRS PRICE	MF01/PC04 Plus Postage.
DESCRIPTORS	Class Activities; Conservation Education; *Curriculum Guides; *Economics; Electricity; *Elementary Education; Elementary School Science; Energy; *Energy Conservation; Environmental Education; Fuel Consumption; *Fuels; Instructional Materials; Natural Resources; Nuclear Physics; Petroleum Industry; *Science Education; Solar Radiation; Utilities
IDENTIFIERS	*Energy Education

ABSTRACT

This packet of units is designed to focus on the technological aspects of energy. Four units are presented, with from 1-4 lessons included in each unit. Units include: (1) basic concepts and applications of energy; (2) steps and processes of energy production and transmission; (3) fuel acquisition; and (4) energy futures and application of non-fossil fuel energy sources. Twenty activity masters are included in this teacher's guide. (RE)

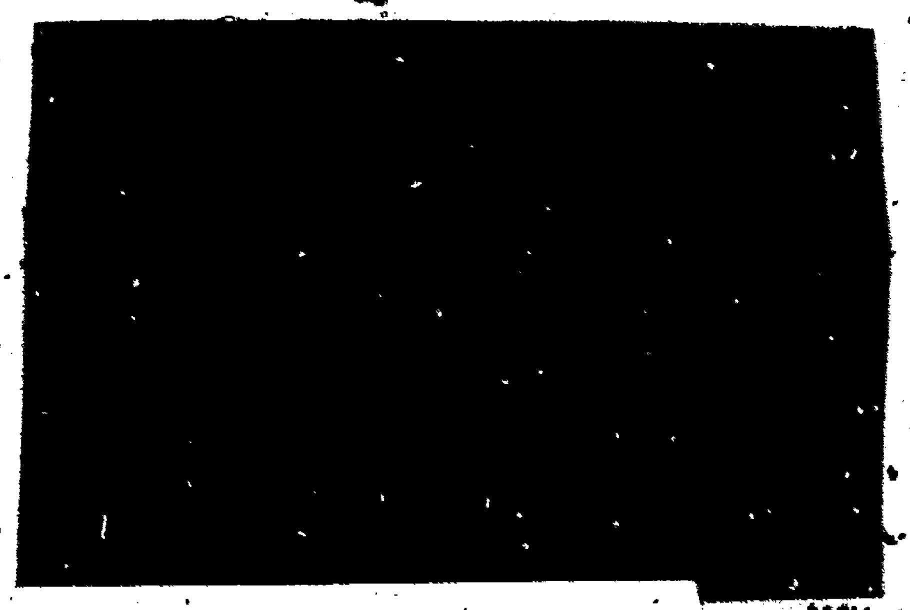
DOE/CA/06083-02

How We Make Energy Work
Grades 4,5,6 Science

April 1980

Prepared by:
National Science Teachers Association
Washington, D.C. 20009
Under Contract Number EC-77-C-01-6083

Prepared for:
U.S. Department of Energy
Office of Consumer Affairs
Washington, D.C. 20585



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TEACHER GUIDE

INTRODUCTION

The guiding principle behind this packet is a focus on the technological rather than the theoretical aspects of energy. Thus, although fourth, fifth, and sixth grade students are introduced in the first unit to the basic concepts and applications of energy, the method by which this is done consists mainly of demonstration and observation.

In the second unit, students become knowledgeable about some of the steps and processes required to make energy available to the user. Students begin by taking school ground field trips which survey building wiring and, if possible, continue their investigation of the transmission and distribution system for providing electricity to the home and school by taking a field trip which follows transmission lines to a generating station. After students discover several primary sources of energy used in electrical production, they turn to a study of the processes of oil drilling and coal mining, including the hazards involved and geological location (Unit 3).

In the final unit, students demonstrate through classroom experiments the conversion of radiant energy to heat and compare chemical and nuclear energy in relation to the quantity of energy produced per unit of matter. In addition, students state the problem of supply and demand in energy and identify conservation measures. They also learn of the place of solar and nuclear energy in the United States when they explore measures being considered for the short-term solutions to the national energy problem.

"How We Make Energy Work" is divided into four units. Each unit contains two to four lessons. In general, a lesson refers to one class period of approximately thirty-five minutes of instruction. For some activities, such as a field trip, the amount of time required depends on the location of facilities and the time it takes to complete the trip. In this case, time allotment is listed as one to four class periods. Completing the entire packet takes approximately two weeks.

ACTIVITY MASTERS

You will find twenty activity masters in the packet "How We Make Energy Work." Each master is designed to help you implement the lessons in the Teachers' Manual. They are suitable for conversion to a duplicating master and will make sufficient copies for your classes.

Answers or anticipated student responses to questions on the activity masters have been included at appropriate places in the Teachers' Manual.

TEACHERS' MANUAL

The teacher material contains a brief overview of each lesson, stating the purpose of the lesson. The objectives point toward the measurable goals for students to achieve, and the materials and time allotment provide basic information in simplified, easy-to-read format.

Each lesson begins with a suggestion for moving the lesson forward or emphasizing the thrust of the lesson. The activities in each lesson are designed to reinforce basic skills in addition to helping intermediate age students learn appropriate facts about energy. It is recommended that you use the lessons and unit in the order we have structured, as they tend to build on one another. You will know the abilities of your students, however, and can best decide if particular lessons or units have or do not have applications for your class. Suggestions for optional activities may offer you alternative approaches. Most lessons include several optional activities for students to perform.

TEACHER BACKGROUND INFORMATION

Material in the next part of these Notes to the Teacher gives additional background information you may use to enrich the lessons and student performance at activity master tasks.

Unit 1
Activity Masters 1-3

[redacted]

Because of its intangible nature, energy usually cannot be studied directly. However, the effects of energy in action can be examined because these effects change the position, motion, state, or temperature of material things. The cause is energy. The forms of energy responsible for the changes may be labeled electricity, heat, chemical, and mechanical energy. Motion may be labeled chemical energy, and light, radiant energy.

Central Heating System

All ordinary central heating systems have the following components: (1) a means of converting an energy source (coal, oil, natural gas, electricity) to heat; (2) a means of transferring the heat to a carrier, i.e. air, water, steam; and (3) a means of transporting these to the rooms of a house. In addition, there is a method of control, usually by thermostats. Some heating systems which utilize electricity heat rooms individually, and are not considered central systems. For Lesson 2, however, the focus is not on these, but on the typical centralized home heating system.

Unit 2
Activity Master 4

[redacted]

Electrical energy is the most common form of energy used in the home. Actually, it is an intermediate form since it comes between the primary sources and end uses such as light, heat, and motion. Electricity is convenient to use because of the means by which it can be distributed. However, it has a distinct disadvantage in that it cannot be stored and so must be produced at the moment of need. The process of converting primary sources of energy to electrical energy, then transmitting it and converting it to its end use results in a loss of energy at every step.

Unit 3
Activity Masters 5-13
[redacted]

The raw material of fossil fuels (coal, natural gas, oil) was the vegetation and animal life present on earth millions of years ago. These organisms died, decayed, and due to geological processes, became buried deep underground. Extreme pressures produced further changes resulting in coal, natural gas, and oil. Peat is the result of similar processes without the extreme pressure. It is found in bogs on the surface of the earth. The extremely long period of time required to form fossil fuels as well as the absence of other conditions places these fuels in the non-renewable classification.

Coal mines vary in depth from a few hundred to several thousand feet. Mining has always been one of the most hazardous occupations. Some of the dangers are obvious: the danger of working in the dark, floods, fire, and cave-ins. Dust, gas explosions, inadequate venilation and accidents are additional problems that present miners with instant and long-range dangers. Surface mining eliminates most of these problems, but adds an environmental one of immense proportions.

Oil is formed by a process similar to the one that produces coal. Instead of being the fossil remains of plant life, however, oil seems to have been formed from sea animals as well as plant remains which sank to the bottom of the great seas that covered the earth in earlier geologic periods. Oil is younger than coal, only a few tens of a million years old instead of hundreds of millions. It was also formed by pressure and the resulting heat. Instead of the simple carbon atoms which form the crystalline solid of coal, petroleum consists of a great variety of complicated hydrocarbon molecules, large molecules of carbon and hydrogen. The petroleum products themselves range from the thick heavy tars and asphalts (the largest molecules), through the oils, gasoline, and kerosene, to the natural gases like methane, which is a carbon atom plus four hydrogen atoms. The various lighter components of petroleum are formed from the heavier ones by "cracking"; they are broken down by the heat. It is this same process which is used in a refinery to produce gasoline (one of the lighter molecules) and the other products, kerosene, diesel oil, and fuel oils, etc.[1]

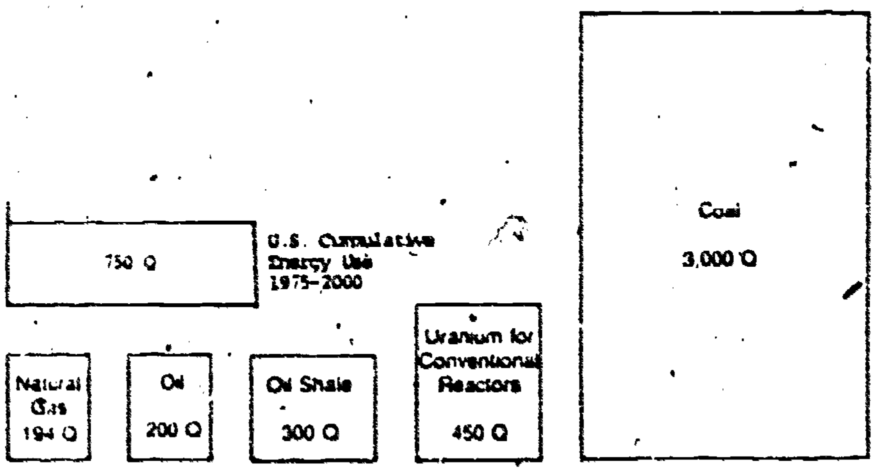
Unit 4
Activity Masters 14-21
[redacted]

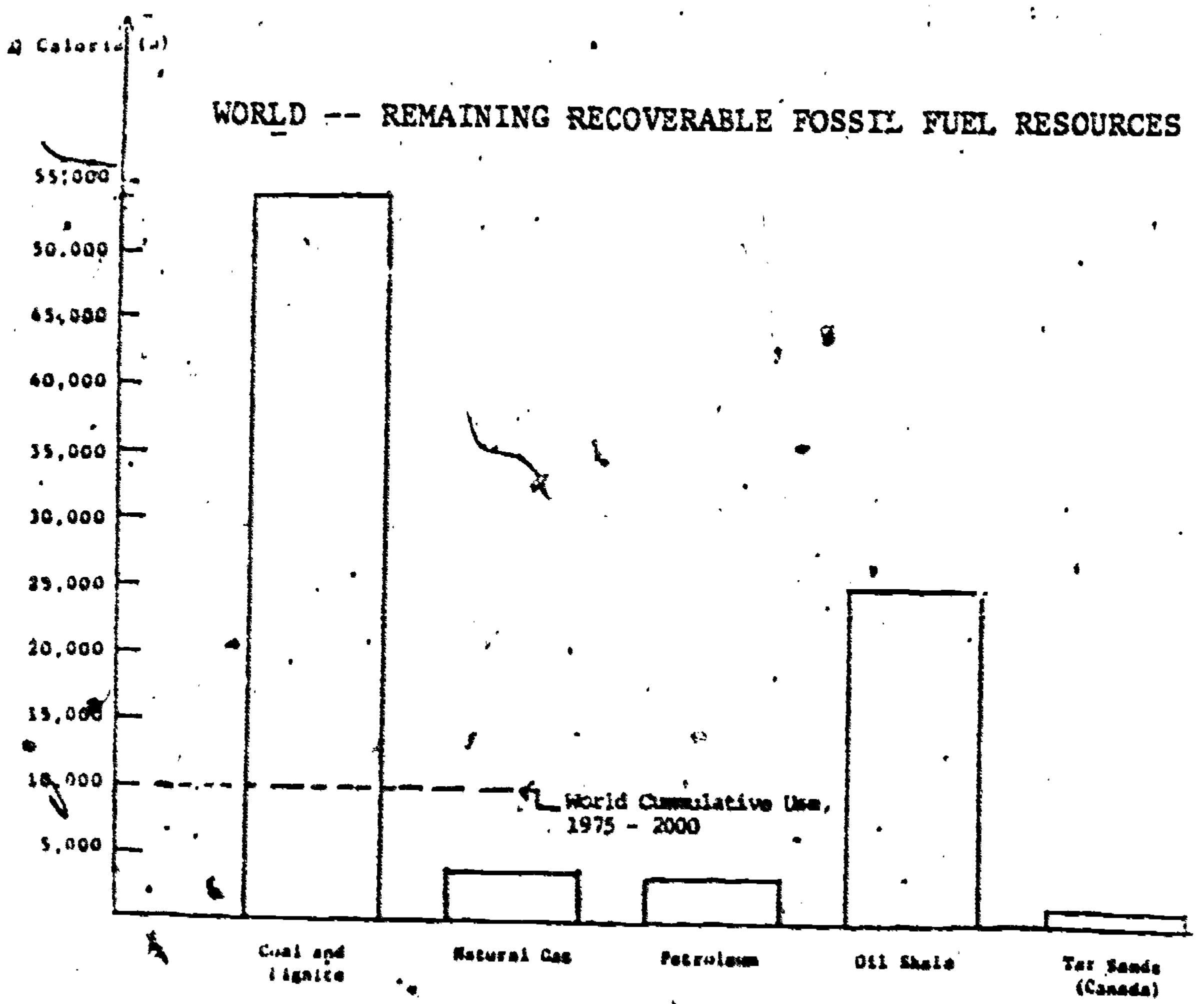
The world depends heavily on fossil fuels as prime energy sources. In 1976, 97 percent of energy consumed came from fossil fuel sources. The customary unit used to discuss world-wide energy consumption and sources is Q Calorie. A Calorie with a capital C (in scientific terminology, the kilocalorie) is the amount of

[1] Energy-Environment Source Book, John M. Fowler (National Science Teachers Association: Washington, D.C.) p. 115, 1975.

energy required to raise the temperature of one kilogram of water one degree Celsius. The Q indicates a quadrillion Calories or (10^{15} C).

U.S. Energy Resources in Quadrillion (Q) Calories: Shown Graphically by Area of the Blocks.





Source: Williams, R., Appendix II, "Fossil Fuel Resources," Electric Power Consumption and Human Welfare, AAAS/CEA, Pg. [illegible] to be published.

Heat energy is carried by conduction, convection, and radiation. The outside of a glass containing a hot liquid gets hot by the heat energy traveling through the glass (conduction). The outside of the glass heats the air which in turn moves away carrying the heat with it (convection). Sunshine feels warm because the rays (radiant energy) are absorbed by the body and converted to heat. Preventing or reducing conduction and convection will keep heat in place longer or prevent heat from entering a cold place.

Solar energy contains many kinds of radiation. The human eye responds to a very small portion of the total radiation. This portion, plus some invisible infrared radiation, can be converted to heat when absorbed by an object. Dark colors are better absorbers than light or shiny reflecting surfaces

None of this conversion should be confused with the heat felt from a sunburn which is the result of skin damaged by exposure to ultraviolet radiation. It should be mentioned that practical use of solar energy is hampered by the lack of continuous sunshine. Some means of storing heat energy or providing a supplementary source during periods of insufficient solar radiation must be provided.

The burning of fossil fuels results in the recombining of the elements carbon and hydrogen with oxygen in the air, and the release of energy in the form of light and heat. Splitting the nucleus of large atoms, such as uranium results in the release of a large amount of energy and the creation of two new nuclei. These so-called fission products are radioactive and so could be harmful to living things, humans in particular. Just as the fire in a huge power plant must be controlled, so must the released nuclear energies be controlled.

An essential characteristic of a nuclear reactor is its closed system which prevents harmful materials from entering the environment.

LOOKING AT THE EFFECTS OF ENERGY IN ACTION

Overview This lesson will help develop an intuitive notion of energy by directing the students' attention to a variety of changes happening to many objects. Students will look at the effects of these changes.

Objectives Students should be able to:
1. Discuss the effects of energy in action.
2. Recognize and give examples of electrical, heat, chemical, and mechanical energy.

Materials
- Electric hot plate
- 400 ml Pyrex beaker half full of water (or use sauce pan)
- Electric hair blow dryer. Tape thin strips of cloth or plastic over it so that they will stream out in front of dryer.
- Flashlight and batteries
- Two fruit juice glasses; one containing a small amount of (5-10 ml) baking soda; the other (5-10 ml) of vinegar.
- Candle (or oil lamp)
- Bucket of water or sink
- Battery-operated electric bell
- Meter stick
- Two chalk erasers
- Book
- Coin
- Copies of Activity Master 1

Time Allotment One class period

Activity	Procedure
Observing and Reporting	The main focus of this lesson is to have students observe each demonstration, record what they see, and tell what is happening and why.

1. Except for the first demonstration, discuss and operate the other demonstrations separately. Begin by having a student volunteer to plug in the hot plate. Ask the students to look at the water in the beaker occasionally, and to raise their hand when they see something is beginning to happen.

   Move on to the second demonstration in the meantime, and then to the third, and so on. However, when someone notices ask: <u>What is happening and why?</u> *(Electricity makes the plate hot; heat makes the water boil.)*
   Allow the water to continue to boil until there is a noticeable lowering of the water level. At this time ask: <u>What has happened to the missing water and why?</u> *(Electricity made the plate hot; heat changed the water to steam; and steam went into the air.)*

2. Ask a student to plug in the hair dryer. <u>What is happening and why?</u> *(Electricity caused the motor to turn the fan. Fan blades push the air. This moving air caused the streamers to move.)*

3. Visibly assemble batteries in the flashlight and turn on the flashlight. <u>What happened and why?</u> *(Batteries (cells) made electricity, and electricity made light.)*
   You may want to add that the filament got hot, or not mention it at this time.

What would happen if there were no batteries in the flashlight? Would it light? Why?

4. Pour vinegar into the glass containing baking soda. What is happening and why? *(A chemical reaction takes place and gas CO_2 is given off - it is what bubbles up.)*

5. Light the candle or oil lamp wick. What happened and why? *(Wax - oil - burned producing heat and light.)* It may be necessary to call attention to the fact that the wick or string is not the burning element.)

6. Connect bell to battery. What happened and why? *(Battery produced electricity and the electricity produced a changing magnetic field which moved the bell clapper making the ringing sound.)* What would happen if the clapper wasn't connected to the bell? *(Nothing.)*

7. Drop an object such as a book on a teeter-totter arrangement of meter stick and erasers. (See picture at left.) Ask: What happened and why? *(Falling object made the stick move which pushed the eraser into the air.)*

ACTIVITY MASTER 1

Help students fill in the blanks. As often as possible, relate the process steps and changes to the demonstrations the students observed in class. Answers will vary; but, in general, will follow these:

1. Kicking (mechanical energy -- *motion--motion--sound.*
2. Furnace (chemical reaction of fuel) -- *burning -- heat.*
3. Vacuum cleaner -- *electricity -- motion.*
4. Stove -- *electricity--heat (and light).*
5. Lamp -- *electricity--heat*
6. Mixer -- *electricity--motion.*
7. Dryer -- *electricity--heat, motion.*
8. Washer -- *electricity--heat, motion.*
9. Television -- *electricity--heat, light, sound.*

Optional Activity

With more advanced classes, ask students to set up the demonstrations, previously outlined, in student activity centers. In each center two or three students set up the energy-in-action mini-lab and introduce the energy concepts to their classmates, who travel from one center to the next. Have center leaders prepare worksheets to hand out ahead of time. These sheets may include a drawing of the object to be observed and sufficient space for student note-taking.

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A CENTRAL HEATING SYSTEM

Overview Using home heating systems as a basis for study, students learn about energy sources, conversions, and some of the techniques by which we use and control energy.

Objectives Students should be able to:

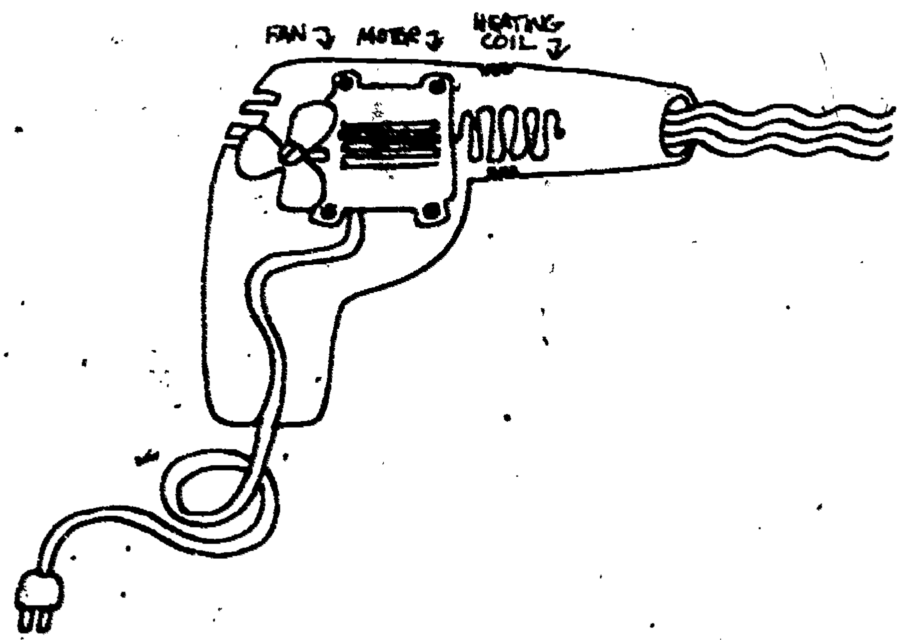
1. Name the common sources of energy used in home heating.
2. Describe how a hair dryer works.
3. Describe the operation of a home heating system, relating it to a hair dryer.

Materials Hair blow dryer (or use a picture)
Activity Masters 2 & 3

Time Allotment One class period

<u>Activity</u>

Observing and Reporting



<u>Procedure</u>

Have a student plug in a hair dryer and turn on the switch. After a moment or two, let students feel the hot air blowing out.
<u>What makes the air move?</u> *(Fan)* <u>What makes the air hot?</u> *(Electricity heating the coil.)*

<u>Where is the coil?</u> *(Between the fan and the outlet.)*
<u>How did the heat get to your hand (or hair)?</u> *(Hot coil heated the air. The fan blows the hot air out.)*

ACTIVITY MASTER 2
[redacted]

Distribute this activity sheet and have students label dryer parts in the appropriate blanks. (See diagram at left.)

Classifying

Sentence order:

The energy source is electricity.

Cause and Effect

Electrical energy is converted to heat energy when it passes through the coil of wire.

The hot coil heats the air in the tube.

The hot air is pushed out by the fan.

Student explanations of the toaster or electric stove will vary, but these sentences should apply:

The energy source is electricity.

Electrical energy is converted to heat energy when it passes through a coil of wire.

The hot coil heats whatever is in a pan on the stove or bread in the toaster.

ACTIVITY MASTER 3

[redacted]

Comparing by Analogy

Before distributing copies of the block diagram of a typical home heating system, ask students: <u>Look again at the picture of a hair dryer. Could a hair dryer heat a house?</u> *(No. Not very much anyway.)*

What would we have to do to the hair dryer to make it able to heat a house? *(Make it much bigger.)* What would be needed to make it bigger? *(Bigger parts, more energy to run it, etc.)*

Option I

Using the overhead projector, a transparency of the block diagram of a central heating system and duplicated copies of Activity Master 3, have students label parts of the home heating system as part of a general class discussion. Deal with these questions:

Step 1. What do you think the primary source of energy is? *(Have students write in Primary Source in the first block (reading from L to R) and the appropriate source; oil, coal, natural gas. It may also be electricity.)*

Step 2. How is the primary source converted to heat? *(By burning. Write Converting Chamber or Fire Box in the inset in the transfer chamber. Put the word "burning" in the same inset section.)*

Step 3. What is being heated? *(Air, water, or steam - it depends on each student's home system.)* Does the transfer chamber have a name? *(Often called Boiler or Jacket. Write in appropriate word.)*

A thermostat is a control device that is activated by temperature changes. The most common working element is composed of two metallic strips which expand by different amounts as the temperature changes. This causes the strip to bend and the thermostat can be set so that this bending makes or breaks an electrical contact at the desired temperature.

Step 4. Is there a Moving Device? *(Fan for air; pump for water. Write in appropriate one.)*

Step 5. Where are thermostats? *(In room, in the moving device, and in the transfer chamber. Have students locate these thermostats. Draw a wire running from room thermostat to fan or pump. Another from the transfer chamber thermostat to moving device (fan or pump). Run the third wire from the room thermostat to the fire box.)*

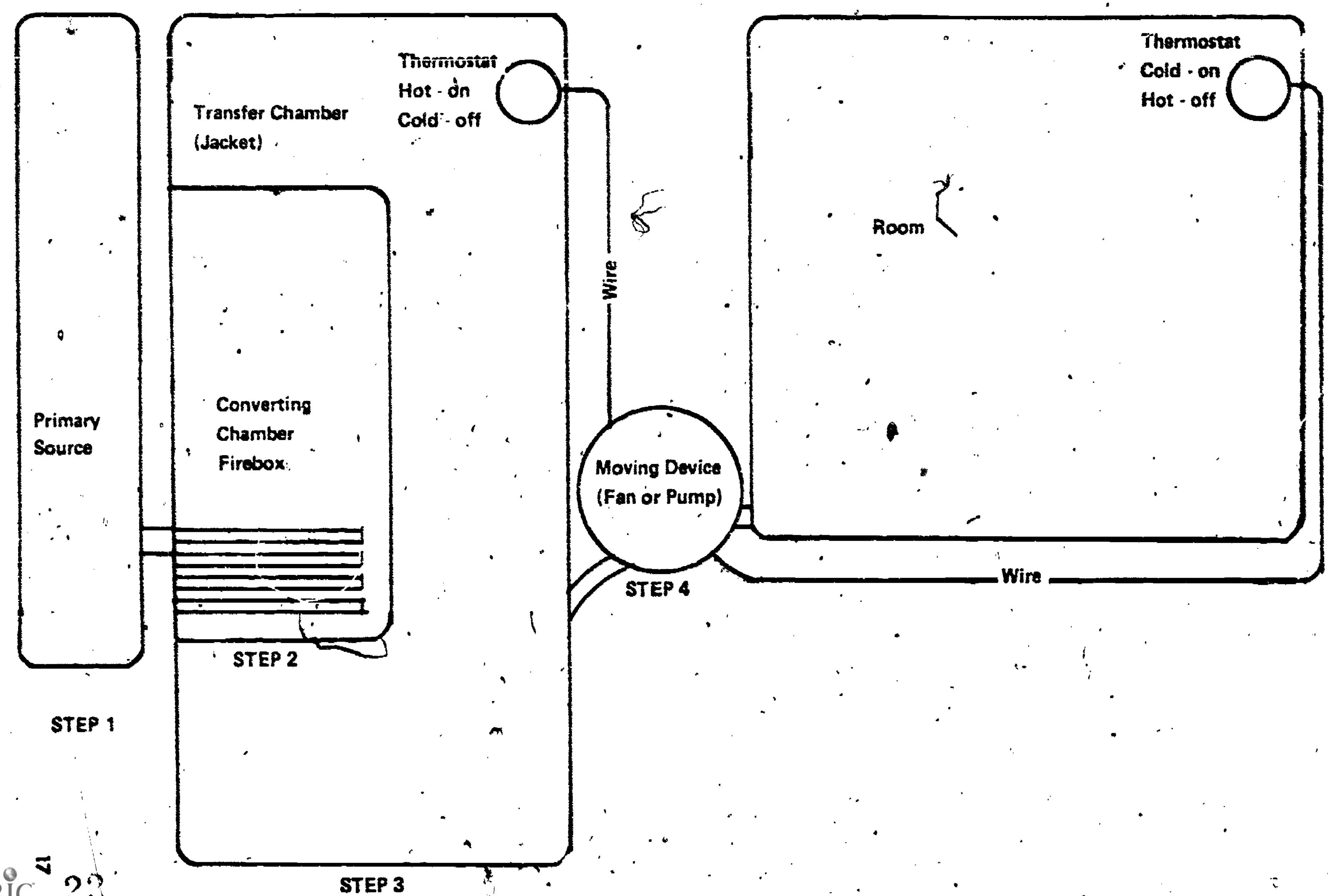
Teacher Use Only

Note: There can be variations in the wiring of the thermostats. It depends on the system. The one shown is a hot-air system. When the room gets cold, the room thermostat turns the fire box on. When the transfer chamber gets hot, the thermostat there turns on the fan. The fan then circulates hot air to the room.

Option 2

Distribute sufficient copies of Activity Master 3 so that each student has one. Take a field trip to the school heating system, following prior agreement with the school custodian. Compare the parts shown on the diagram to the school's central heating system. Label each part and tell what it does.

CENTRAL HEATING SYSTEM



FROM THE GENERATING STATION TO YOU

Overview This lesson focuses on the complex steps involved in the production of energy, starting with the primary sources of energy and ending with the consumer. Electricity is the subject of the study because of its near universal use.

Objectives Students should be able to:

1. Describe an electrical transmission system.
2. Explain the main function of the main parts of a generating station.
3. List the most common primary sources of energy used to generate electricity.

Materials Mural paper
Student Field Guides (20-30 copies)
Activity Master 4

Time Allotment One-four class periods

Activity	Procedure
Energy Tracing: Cause and Effect	Go outside and, with the help of the custodian or school building engineer, find the place where wiring enters the building. Check these items: 1. Are the wires insulated? 2. Do wires come in pairs? Are they in sets of three, sometimes in a single cable? 3. What is the meter for? Begin a classroom mural that will eventually show the various elements involved in the production and transmission of electricity. The first pictures will include the school building and the electrical wires leading into it.

(Some of the elements that should be included in the mural are shown on page of this booklet.)

Optional Activity

Have a small group of students compose a letter to the local utility company asking for assistance in planning a field trip to a generating station and a route to see transmission lines.

Observing and Reporting by direct experience

Part 2

Take a field trip starting with the school building and follow the power lines to a large transformer station. Have students use Student Field Guide sheets to record their observations. Some elements that should be noted are:

1. Increased size of cable, or that the three wires become widely separated.

2. Wires in cables are very high and insulated from poles or towers.

3. Occasionally wires lead off the main wires to other buildings. (A large wire may carry enough electricity for many buildings.)

4. Occasionally there is a tank-like container on a pole near a building. The container has wires leading out of it. (It's called a transformer. It operates somewhat like

the control box of a toy electric train, which changes a large voltage to a lower one. Voltage may be loosely explained as an indication of the push which causes the electricity to flow, higher voltage, more push.

5. At the large transformer station, supply cables can be seen. Where are they? How many? Which direction are they going? Why? *(Answers will depend on direct observation at the facility.)*

6. The supply cables originate at the generating plant.

Add pictures of transmission lines and transformer station to mural. Show buildings and houses, too.

Part 3

Visit a generating station. Distribute Field Guides, one to each student. Components to be observed at the generating plant should include the following:

1. A generator which converts motion supplied by a turbine to electrical energy.

2. Turbine which converts heat energy to motion or mechanical energy.

3. Boiler which converts water to steam by using heat from burning a fuel.

Generating Plant

Fill in the blanks:

The *oil-coal-gas* supplies the energy which is converted to heat in the boiler. Steam from the boiler is converted to *mechanical* energy in the *turbine*. The *mechanical* energy is converted to electrical energy in the *generator*.

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4. A supply of a primary source of energy - coal, gas, oil, or nuclear fuel.

Putting It Together
Apply the Learning

ACTIVITY MASTER 4

[redacted]

Distribute copies of slide-making materials and energy in action pictures. Tell students that the pictures are scrambled. Have students follow the directions on the Activity Master in making the films. (They may color the pictures, if they wish.)

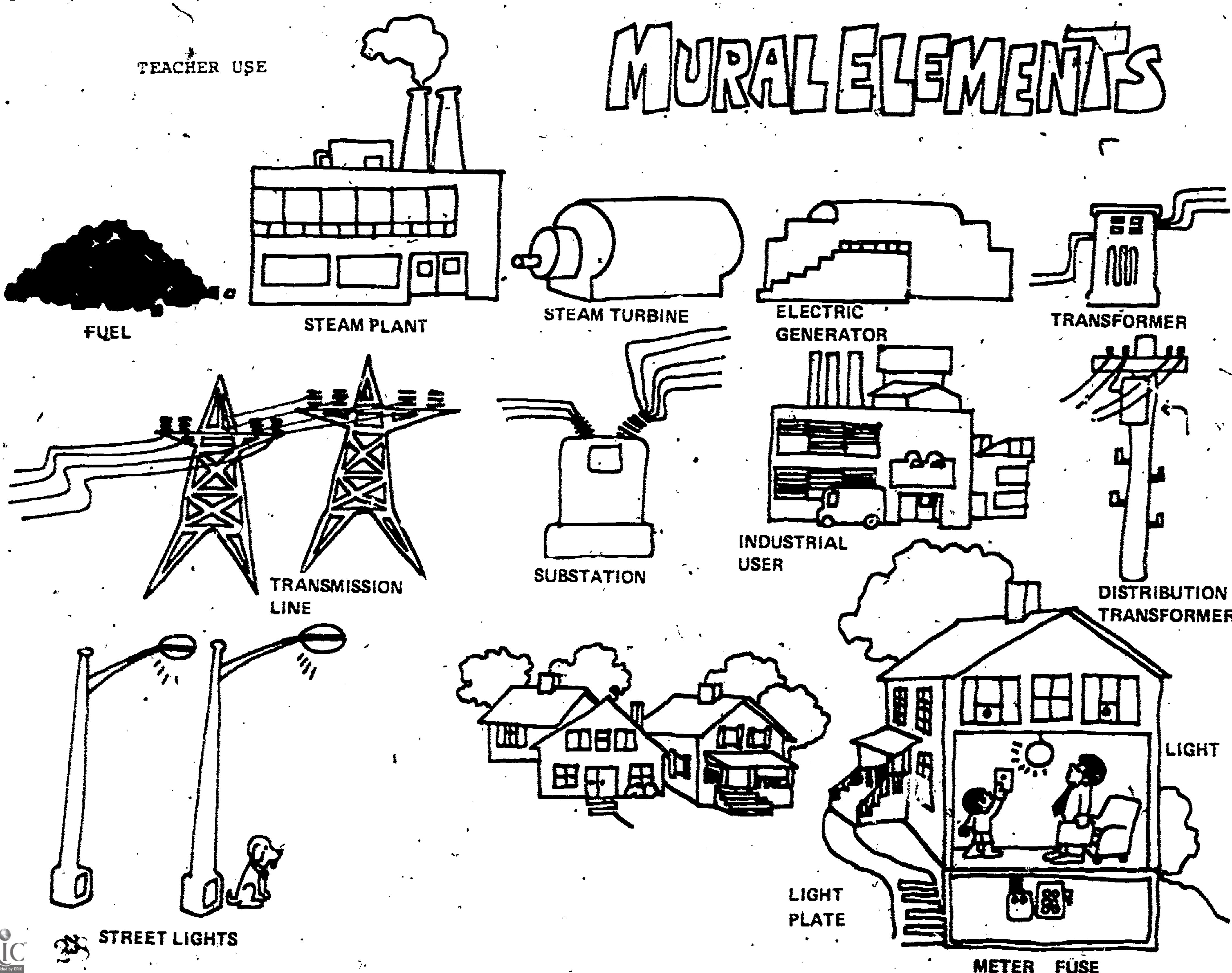
Classifying

Discuss primary sources of energy and differentiate between these and end uses of energy before the film-making activity is begun.

Invite students to think of other examples of mechanical, radiant, ~~electrical,~~ chemical, and heat energy. Have students draw their own picture for the film, if they wish to do so.

TEACHER USE

MURAL ELEMENTS



TIME LINE FOR FOSSIL FUELS

Overview

This lesson conveys to the student the extremely long period of time required to produce fossil fuels, part of the reason why they are classified as non-renewable sources of energy.

Objectives

Students should be able to:

1. Describe the process by which fossil fuels were formed.
2. State the time required to produce fossil fuels in meaningful units.

Materials

Activity Masters 5, 6, and 7
Meter stick
Sample fossils, if possible

Time Allotment

One class period

Activity	Procedure
	ACTIVITY MASTER 5 [redacted]
Energy Time Line	Distribute copies of the time line. Have students look carefully at each step and note the time period. Use these guide questions:

1. How do we know that this kind of life form existed about this time? *(Point to period 300 million B.C. Fossil evidence exists today.)*

2. What is a fossil? *(An imprint of the organism made in soft earth and preserved over the millions of years.)*

3. Where are fossils found? *(Usually under the surface where they were buried.)*

4. What causes them to be buried? *(Changes in the earth's surface due to earthquakes, erosion, etc.)*

5. Why do you think we call coal a fossil fuel? Why do you think we call oil a fossil fuel? Why do you think we call natural gas a fossil fuel? Which caused formation of natural gas?

Discuss the fact that vegetation (plant) decay resulted in coal; and animal decay resulted in oil.

Sequencing

ACTIVITY MASTER 6

[redacted]

Have students follow the sequence of events that resulted in the formation of coal. Have students write the story of coal in their own words.

ACTIVITY MASTER 7

[redacted]

Have students examine the pictures showing the formation of oil. Have students write the story of oil in their own words.

Measuring Time

Optional Activity

Have students examine a meter stick and become familiar with the units of 1 meter, 1 centimeter, 1 millimeter.

Go outside to the playground and have students measure a line 100 meters long, marking off every meter. Call one end of the line "Today." Give the date.

FOSSIL FUELS

TODAY

100 Meters
(Playground)

Tell students the line represents the 300 million years needed to produce fossil fuels from the original vegetation. (Have students look around. Are there trees today that look like the trees or plants in the time line picture?)

Give students the following table:

100 meters	=	300 million years
1 meter	=	3 million years
1 cm	=	30 thousand years
1 mm	=	3 thousand years
0.5 mm	=	1,500 years

Have students note when A.D. began about 1978 years ago. This time span is represented by 0.5+ mm. Appoint a student to stand on the TODAY marking. Another should stand on the 0.5 mm mark. (They will stand side by side.) Both students represent the time of nearly two thousand years.
Have another student volunteer to stand at the 100 meter mark. This mark represents the formation of coal.

Guide questions:

1. Why can't we wait for nature to produce more fossil fuels?

2. Why can we call fossil fuels non-renewable fuels?

MINING COAL

Overview In this lesson, students examine two types of coal mining and describe the steps in processing coal. They identify common environmental and human health and safety problems associated with mining.

Objectives Students should be able to:

1. Describe two types of coal mines.
2. Identify the steps used in processing coal for home and industrial use.
3. State some of the environmental problems of strip mining.
4. List health and occupational hazards of deep mining.

Materials Activity Masters 8, 9, 10, and 11
Samples of coal, if possible

Time Allotment One class period

Activity

Observing and Reporting information from prepared sources

Procedure

ACTIVITY MASTER 8
[redacted]

Distribute copies of pictures of deep-shaft coal miners. Before students complete the activity, ask:

1. Why are the men wearing hard hats? *(Protection from dirt, coal chunks, rocks - all of which could fall on their heads.)*

2. Why do they have lights on their hats? *(It's dark in underground mines.)*

3. The lights used to be lanterns which burned a gas to make light. Why do you suppose workers changed to electrically powered lamps? *(Coal, mine gas, and coal dust can be ignited by a flame.)*

Note to Teacher:
Underground mining follows a room-and-pillar mining plan. About half the coal is removed from the seam by carving out intersecting tunnels. Between the tunnels, large blocks of coal pillars are left standing to support the mine roof. When pillars are no longer needed, they are sometimes removed to recover additional coal.

The five major steps are:
1. Cutting - slices cut in the coal to allow the solid coal to shatter more easily.
2. Drilling - holes are bored for explosives.
3. Blasting - spark-proof explosives are used to shatter the coal.
4. Loading - coal is put on cars and taken out of the mine.
5. Roof Bolting - roof support is put in place.

Ventilation is installed and coal vein is ready for next cycle.

Adapted from Energy from Coal, Office of Fossil Energy, ERDA, Washington, D.C.

4. What other risks do you think miners take? *(Student answers will vary.)*

Have students complete their drawings.

ACTIVITY MASTER 9

In this activity, call attention to coal veins, shafts, and levels underground. Deal with these questions:

1. How do miners get to the various levels to mine coal? *(They use elevators.)*

2. How is coal in the tunnels mined? Why is mining done in this manner? *(It is dug from lower to higher, for safety reasons, to keep the roof from caving in on miners.)*

3. What do you think the air shaft is for? *(Ventilation, brings clean air to miners.)*

4. Can you find the two miners we looked at before? Tell how their jobs are important.

Collecting Information

Special Note to the Teacher:

Coal Preparation

Coal preparation involves mechanical cleaning and sizing, usually carried out in a water medium. A prepared coal has a lower moisture and ash content than run-of-mine coal. The overall result is a coal product with more nearly uniform physical properties and a higher heat value.

Major preparation operations are performed in the coal preparation plant; however, sometimes coal is cleaned at the mine as well. Here during manual cutting and loading, the miner can distinguish between coal and rock and discard accordingly. Iron can be removed from coal by magnets.

There are two primary objectives in crushing coal. One is to reduce run-of-mine to sizes suitable for cleaning or further reduction (pulverizing); the other is to reduce the coal to market sizes. Primary breaking and crushing may occur at the mine or at a preparation plant.

Raw coal blending is generally practiced where a high degree of product quality is necessary.

Energy From Coal, Office of Fossil Energy, ERDA, Washington, D.C.

ACTIVITY MASTER 10
[redacted]

Hand out pictures of surface mining. Have students locate the vein and the overburden. Write in these words on the picture.

Locate the workmen. Compare the workmen to the height of the overburden and the power shovel. How much coal do you think the shovel could pick up in each load? *(The biggest one can shift 325 tons in one load.)*

What will happen to the land after it has been mined? *(Discuss the process of replacing the overburden and re-seeding the soil.)* Why should the land be reclaimed? Who should pay for putting the land back in place? *(Discuss the meaning of responsibility.)*

ACTIVITY MASTER 11
[redacted]

Ask: What does this picture show? *(Coal preparation; processing bituminous coal.)*

Point to each step. Ask: What do you think is happening to coal here? *(Review meaning of crushing, sizing, washing, grading, blending, pulverizing.)*

Why do you think coal needs to be washed? *(To get rid of some of the sulfur and dust.)* Is coal dirty? *(Yes.)*

Talk about pollution of air and streams, if class interest is running high.

Ask students to complete the Activity Master.

REFINING OIL

Overview

In this lesson the students are introduced to the many products that result from the distillation of crude oil. Distillation is presented as a process of boiling and condensing.

Objectives

Students should be able to:

1. Name several common products resulting from the refining of crude oil.
2. Identify distillation with boiling and condensing fluids.
3. Identify the steps on refining crude oil.

Materials

Samples of crude oil, gasoline, kerosene, light oil (household), heavy oils (car oil), grease, wax. These should be placed in clear plastic jars with caps on them. All containers should be filled about half full, and each should be labeled. CAUTION: All these materials are flammable. Make sure there are no open flames in the room.
Activity Masters 12 and 13.

Time Allotment

One class period

Activity	Procedure
Observing and Classifying	ACTIVITY MASTER 12 [redacted] Have students examine each sample for such characteristics as color and degree of thickness. Allow students to handle the containers. Then list the characteristics of each on the activity master. Call attention to the crude oil sample. Do you see all the others in this jar? ACTIVITY MASTER 13 [redacted] Distribute class copies of the diagram of the refining

process. Explain that distillation is a process of boiling a liquid to form a vapor and then cooling the vapor to reform the liquid.

CAUTION: Demonstrating this process with the samples in the room is not advised.

Classifying

Extending the Learning

1. Have students make a list of petroleum products. Use a chart to classify these products.
   Clothing Fuels Toys Supplies

2. Make a report on the petro-chemical industry. Have students include actual samples of petro-chemical products as part of their reports.

37

SUPPLY VS. DEMAND IN ENERGY

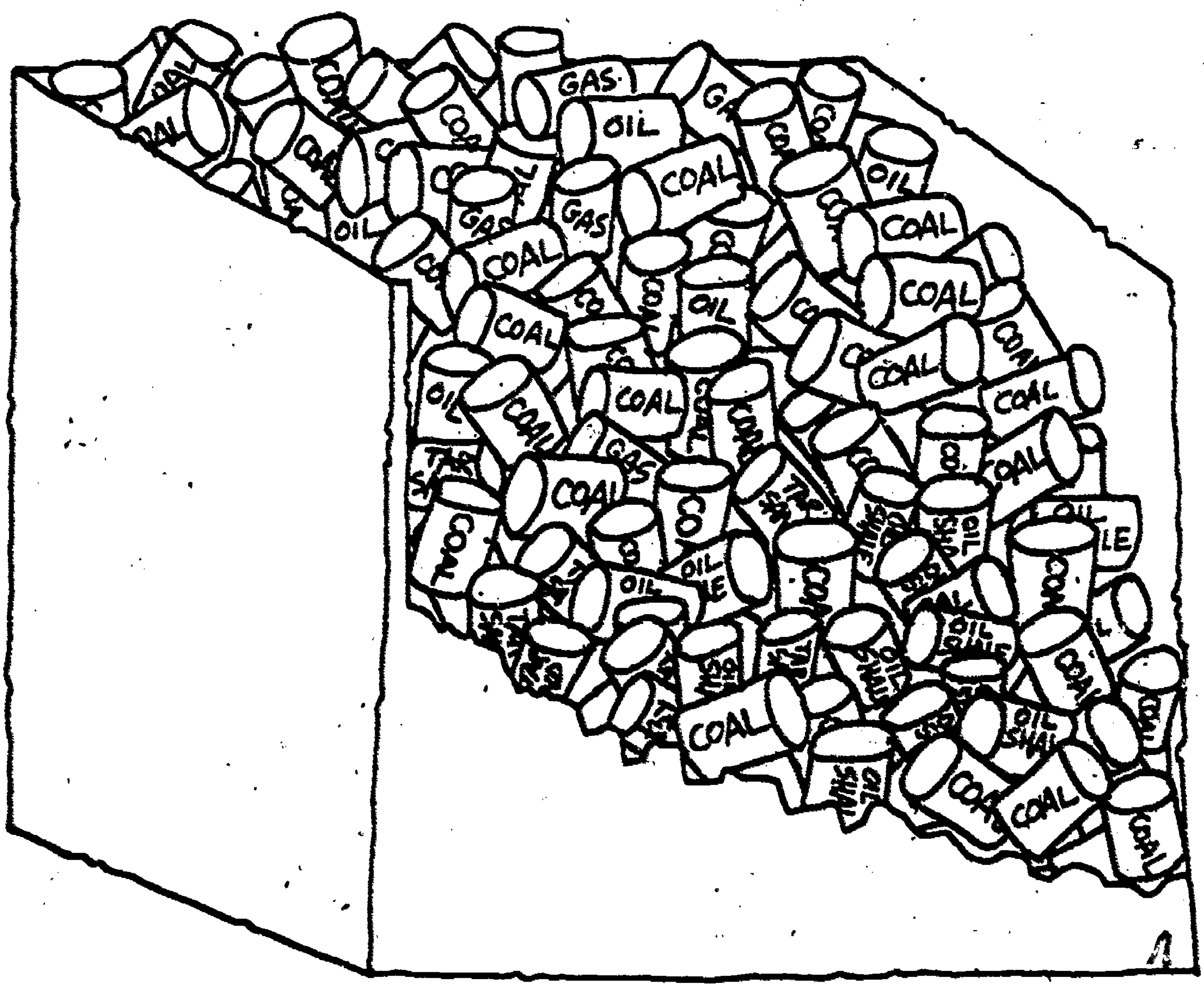
Overview This lesson emphasizes the reasons why fossil fuels are considered non-renewable and encourages the students to compare available fossil fuel sources with present demand for them. Conservation is introduced.

Objectives Students should be able to:

1. Interpret a circle graph to show world energy consumption.
2. State the limits of fossil fuel resources in terms of years.

Materials 200 soda cans (or 200 objects having similar characteristics)
Activity Master 14

Time Allotment One-two class periods (Cans will need to be collected over a week or two. These should be used cans.)



Activity	Procedure
Predicting	Have students collect 200 soda cans (or 200 of something of similar size.) Paint the cans, or dab a spot of the appropriate color on them, according to the following chart. (The number of cans painted a particular color is based upon the information shown on the graph in the Teacher's Background Material, World Remaining Fossil Fuel Resources.)

No. of Cans	Color	Represents Fuel
125	Black	Coal
7	Dark Brown	Oil
8	Blue	Natural Gas
57	Green	Oil Shale
3	Tan	Tar Sands

Activity	Procedure
1. Supply and Demand	Mention that Oil Shale and Tar Sands are found on the earth, but at the moment are not used because of the difficulty and cost of obtaining them.
	Put all cans in a large carton and mix them up.
	Assign each student a 25 year time period, starting with 1975-2000, and ending with whichever 25 year span may be assigned to the last pupil in your class. Have each student write in the time period he or she has been assigned on a piece of paper and pin it to clothing.

Have students go in turn to the carton and pick out any 22 cans, and count off the colors for a tally. On the chalk board, keep a running tally of the cans.

TALLY

Cans	Sample Years				
	*Total Avail.	1975 2000	2001 2025	2026 2050	2051 2075
Coal	125				
Oil	7				
Nat. Gas	8				
Oil Shale	57				
Tar Sands	3				

*The 22 cans represent the amount of energy consumed in a 25 year span.

Have a student call out when any one color is used up. At this point discuss what might happen when all of the (oil, coal, natural gas) is used up. Look in the carton. How much longer do you think the fossil fuels will last? Then what do you think will happen?

Remind students that oil shale and tar sands are not used at present. If these are removed from the pile what would be the result?

2. Short-term solution?

Conservation

Search for new fuels

Optional Activity

Don't use the oil shale and tar sands cans. These green and tan cans may not be drawn from the carton until the years when they can be processed profitably. All other cans are placed in the carton and mixed. When the last can is removed, ask:

1. How long do you think the remaining fossil fuels will last?

2. What should we do about the oil shale and tar sands sources?

3. Are there other sources of energy other than fossil fuels?

4. What can we do to make fossil fuels last longer?

   a. Conserve. Use them more sparingly.
   b. Use other sources.

ACTIVITY MASTER 13

[redacted]

Distribute copies of circle graph and set of questions. Have students complete the activities.

Answers to Questions:

1. Oil, Coal, Natural Gas.

2. Nuclear, Hydroelectric Power, Geothermal, Wood, Solar (including wind), etc.

3. Student answers will vary. Circle graph shows world-wide dependence at present on fossil fuels.

STOPPING THE HEAT LEAKS

Overview

In this lesson students identify the essential element of heat loss and the solutions being considered.

Objectives

Students should be able to:

1. Name and describe some energy conservation measures; especially building insulation.
2. Demonstrate how heat can move around a room and leave a room.

Materials

4-6 Thermometers (0-50°C)
2 small Juice Glasses
1 Water Glass and Styrofoam cup of equal size
4-6 large Water Glasses or Jars with lids (large enough to hold juice glass placed inside each jar)
Activity Masters 15, 16, and 17

Time Allotment

One class period

Activity	Procedure
Observing and Recording	Have students place thermometers at the various locations in the classroom suggested by the Room Temperature Chart illustrated in the Activity Master. (Tape thermometers in place.)
	ACTIVITY MASTER 15 [redacted]
	Distribute Room Temperature Chart to each class member. Select student volunteers to read the thermometers at various intervals and report to the class.
	Discuss reasons for the differences in temperatures. (Heat rises; cold air is near floor; windows are cooled by outside air; air carries heat away at doorways, etc.)

Ask: How can window temperatures become warmer? *(Accept suggestions. Encourage discussion of storm windows.)*

ACTIVITY MASTER 16

[redacted]

Discuss insulation of homes and buildings. In winter, a furnace puts heat energy into a house, but heat will continue to leave through the walls, windows, floors, and roof. Insulation keeps the heat from leaving as fast.

How can insulation help everybody in a time of energy shortage? *(Save valuable and limited fossil fuels.)*

ACTIVITY MASTER 17

[redacted]

Testing An Hypothesis

Have a small group of students place equal amounts of hot water in an ordinary glass or pyrex beaker and a styrofoam cup. Take the temperature of the water in each. Then place pieces of cardboard over each container to insure that heat loss is through the container and not through the opening.

Record the temperature of each on a chart or graph after 1 minute. In which container did the water stay hotter? Why?

Observing and Reporting

Hand out small magnifying glasses. Ask students to examine bits of the styrofoam cup and tell or draw a picture about what they see. *(Full of air pockets.)*

How can air pockets in something keep heat in? *(Air cannot carry heat away if it is trapped in the pockets.)* Would layers of something act like air pockets? *(Yes. They would trap the air and prevent it from carrying body heat away.)*

When might we want to let air carry body heat away — in winter or summer?

Does loose, thin clothing let air carry away heat from our bodies?

Explain how wearing a down jacket might not be a good idea in summer. Have students use the word <u>insulation</u> in their explanation.

SOLAR ENERGY

Overview

This lesson presents the idea that the sun's radiation can be converted to heat. Some techniques to increase the efficiency of the process will be examined. Converting solar energy to electricity is mentioned.

Objectives

Students should be able to:

1. State the relationship of various colors to heat conversion.
2. Explain the problems of utilizing electric conversion of solar energy for home use.

Materials

2 identical Boxes about 30 cm x 30 cm x 30 cm
2 identical tin cans with labels removed
3-5 Thermometers
Black and White Paint
Plastic Wrap
Activity Masters 18, 19, and 20

Time Allotment

One class period

Activity	Procedure
Observing and Reporting	ACTIVITY MASTER 18

[redacted]

Use this activity master as a lab data collecting sheet. Ask students to graph the results as an additional activity.

This activity asks the students to:

Paint one box dull black and the other box white. Cut a window in one side so that a thermometer placed on the inside of the box may be seen and read (see drawing on Students' Activity Master 17 handout). Cover the "window" with clear plastic.

Observing and Reporting

Place the boxes in a sunny place. Read and record the temperature in each box every 5 minutes.

In the second experiment, have students paint one ordinary tin can black and one white. Fill both with exact amounts of cold water and place a thermometer in each can. Put the cans in a sunny place. Have students read and record the temperatures every 5 minutes.

<u>Answers to Student Questions:</u>

1. *Black box or tin can got hotter. Black is the better color for absorbing and converting the sun's rays to heat.*

2. *Warmer house - black roof.*

3. *Cooler house - white roof.*

4. *Black is better for absorbing and converting the sun's rays to heat.*

ACTIVITY MASTER 19

[redacted]

Show the students the picture of a modern solar house. Ask: What color might be best to paint the inside of the collector? Why? *(Black; to absorb the sun's heat better.)*

Why do you think the collector is covered with glass? *(Glass lets the sunlight in but prevents air from carrying the heat energy away.)*

In what direction does the roof collector face? Why? *(It faces south. The sun's* *rays come mostly from this direction, in North America at least.)*

Why do you think there is an auxiliary heater in the house? *(Some days the sun doesn't shine for a long enough period. The heater will help maintain comfort.)*

ACTIVITY MASTER 20

[redacted]

If possible, have students examine a light sensitive meter. Have students note that increasing the amount of light shining on the photo cell increases the action of the needle.

Distribute the diagram of a light meter. Have students locate the various parts of the meter. Then answer the question on the meter.

Answer to Student Question:

It would take too many photo cells to replace the use of 1 flashlight battery.

NUCLEAR ENERGY

Overview

This lesson introduces the student to the enormous quantity of energy released by a small amount of nuclear material. The closed circuit energy exchange system in a nuclear power station is described.

Objectives

Students should be able to:

1. Compare the energy released by nuclear fuels to the energy produced by fossil fuels.
2. Identify some of the hazards of nuclear reactor plants.
3. Describe the basic elements of a nuclear reactor energy exchange system.

Materials

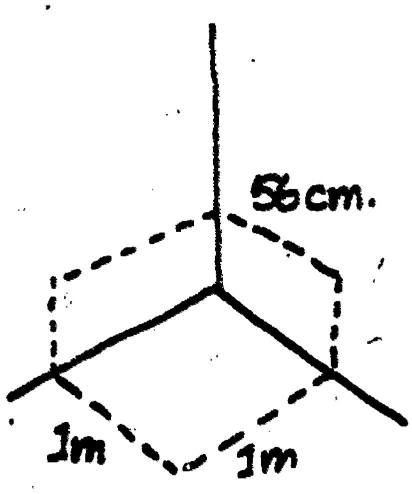
Piece of Chalk 15 mm long
Masking Tape
Activity Master 21

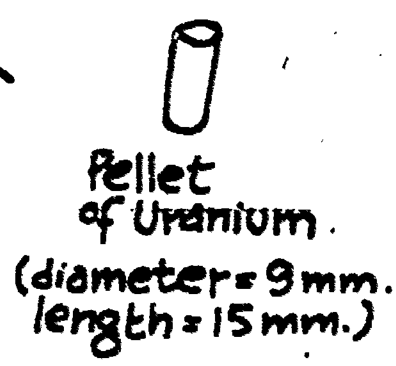
Time Allotment

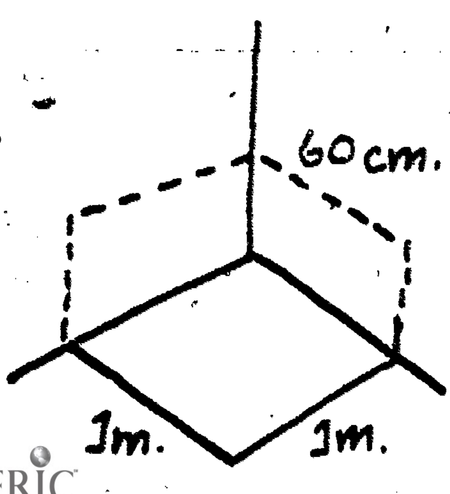
One class period

Activity	Procedure

Comparing







Begin with a review of the primary sources of energy. Have students list them again: Fossil Fuels - coal, oil, natural gas; Hydroelectric; Nuclear.

Call students' attention to the size of the chalk that you are holding. (See left for size.) The chalk size represents a <u>pellet</u> of uranium, which is a nuclear fuel. Real uranium would be too expensive and too dangerous to use in a school.

Help students measure a corner of the classroom into the following dimensions and mark the area with masking tape. The walls will form two sides of a square, and masking tape represents the other two sides. (See diagram at left.)

Next, measure up the wall at the corners 56 cm. Place the chalk pellet (representing uranium) in the square.

Tell students that the pellet produced as much energy as the amount of oil they could fit into the space.

Measure another space, in another corner. Use the same marking method. This time, however, measure up 60 cm. Place pellet inside the square as before.

The 60 cm square represents the amount of well-packed coal that would equal the same energy as the tiny nuclear pellet.

Take the comparisons further by asking:

1. Do you remember what kind of energy is produced when fossil fuels are burned? *(Heat, light.)*
2. What is the name of a place where fossil fuels are burned under controlled conditions? *(Boiler or Boiler House.)*

List on the board the energies produced in a nuclear reactor. Do you think it will be the same as energies produced by fossil fuels?

1. Heat
2. Light
3. Other invisible radiations such as X-rays.

Acquiring and Reporting Information

ACTIVITY MASTER 21

[redacted]

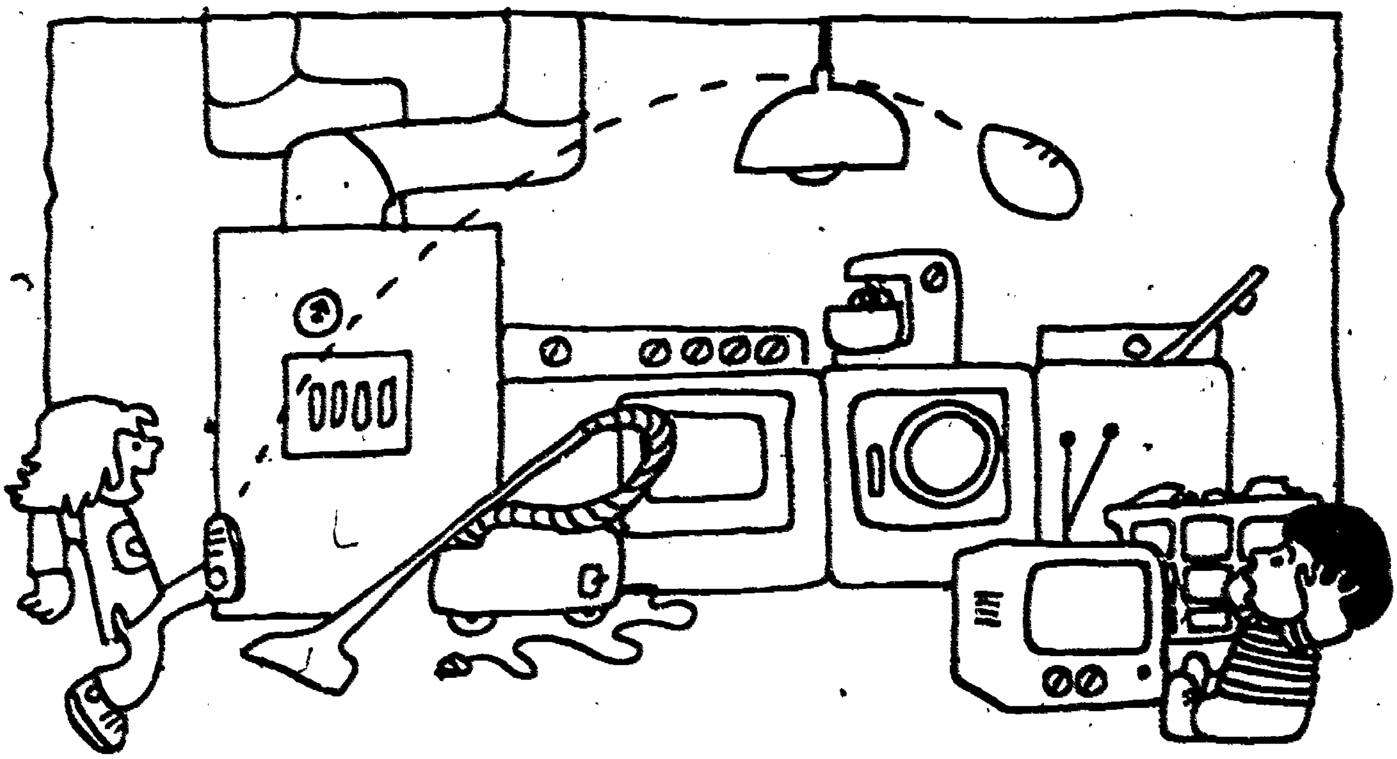
Distribute diagram of a reactor. Have students trace the flow. Have them suggest appropriate

Activity	Procedure
	colors to represent steam and water.
	Identify a closed system. Discuss the pathways with particular attention paid to the fact that the same water is used over and over. Why is it closed? *(To prevent harmful nuclear radiation and radio-active material from escaping.)*
	Where are the control rods and shields? What do these things do? *(The amount of energy produced is controlled by lowering the control rods into the core.)*

HOW WE MAKE ENERGY WORK

Student Activities Book

WHAT IS HAPPENING AND WHY?



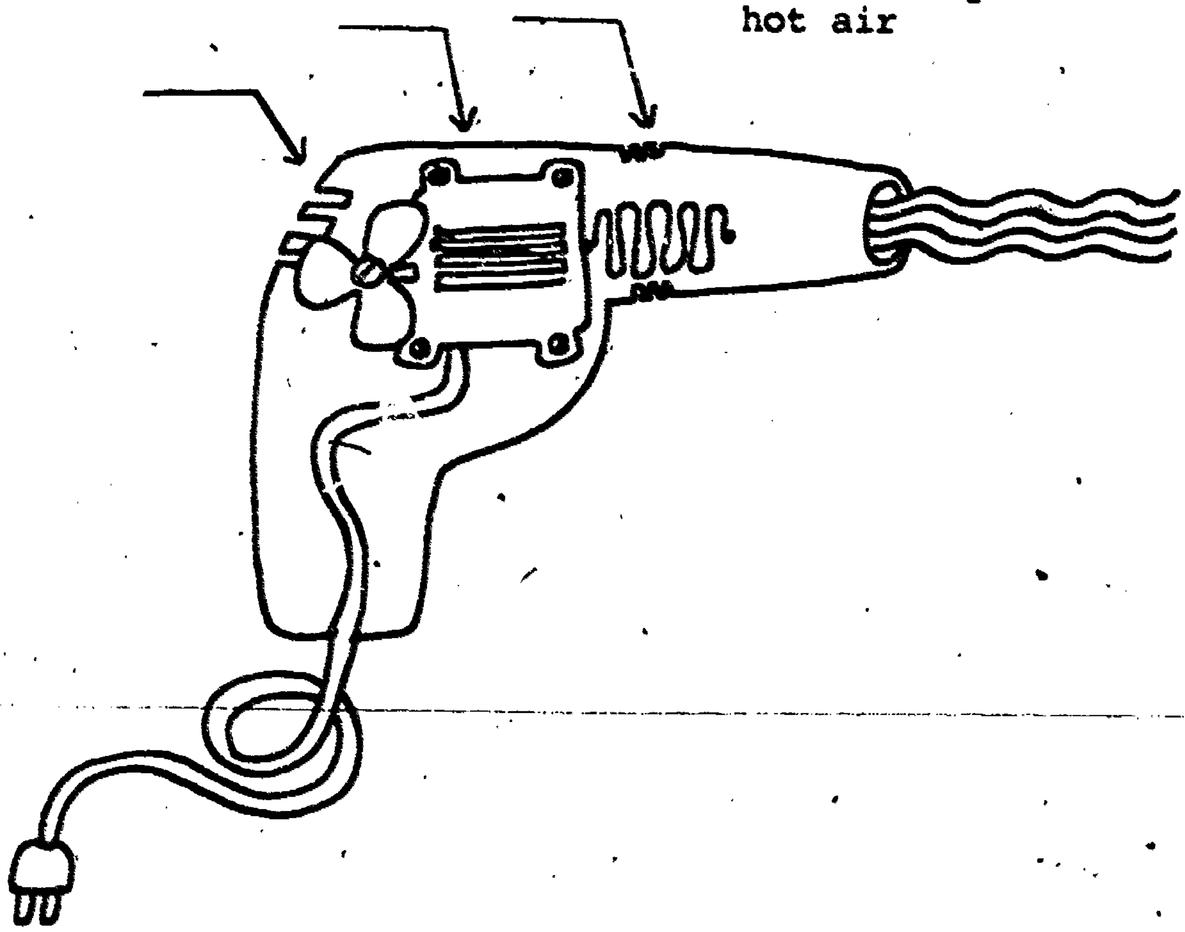
How is energy in action being shown here? List each action, starting with the girl kicking the football, and ending with the TV set. Write in what is happening and why. The first two have been done for you.

Name	Process	Changes	
Kicking	1. *motion (foot)*	*motion (ball)*	*sound*
Furnace	2. *burning*	*heat*	
Vacuum Cleaner	3.		
Electric Stove	4.		
Electric Light	5.		
Electric Mixer	6.		
Electric Dryer	7.		
Electric Washer	8.		
Television Set	9.		

2

Write the words in the correct blank:

fan
heating coil
motor
electricity
hot air

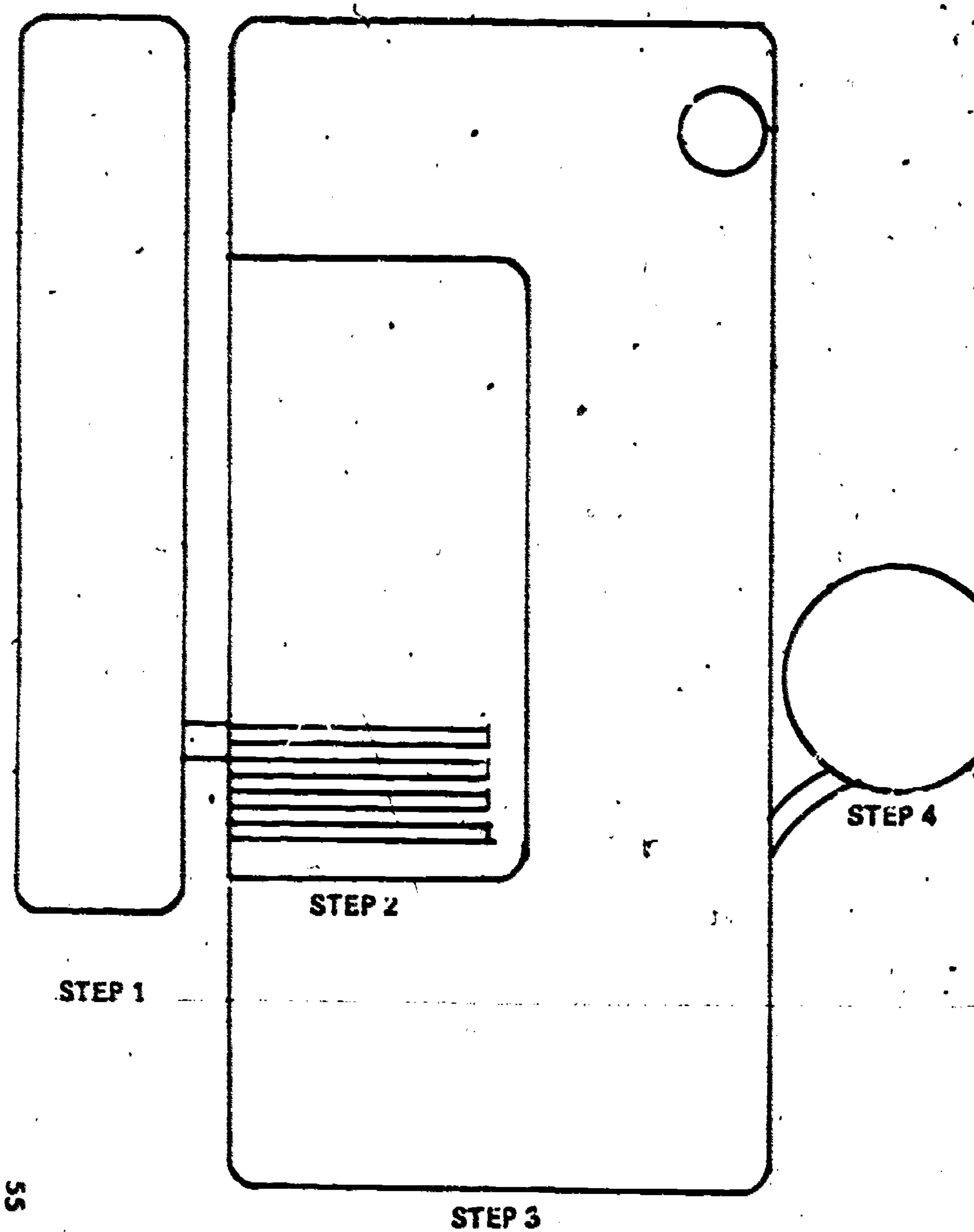


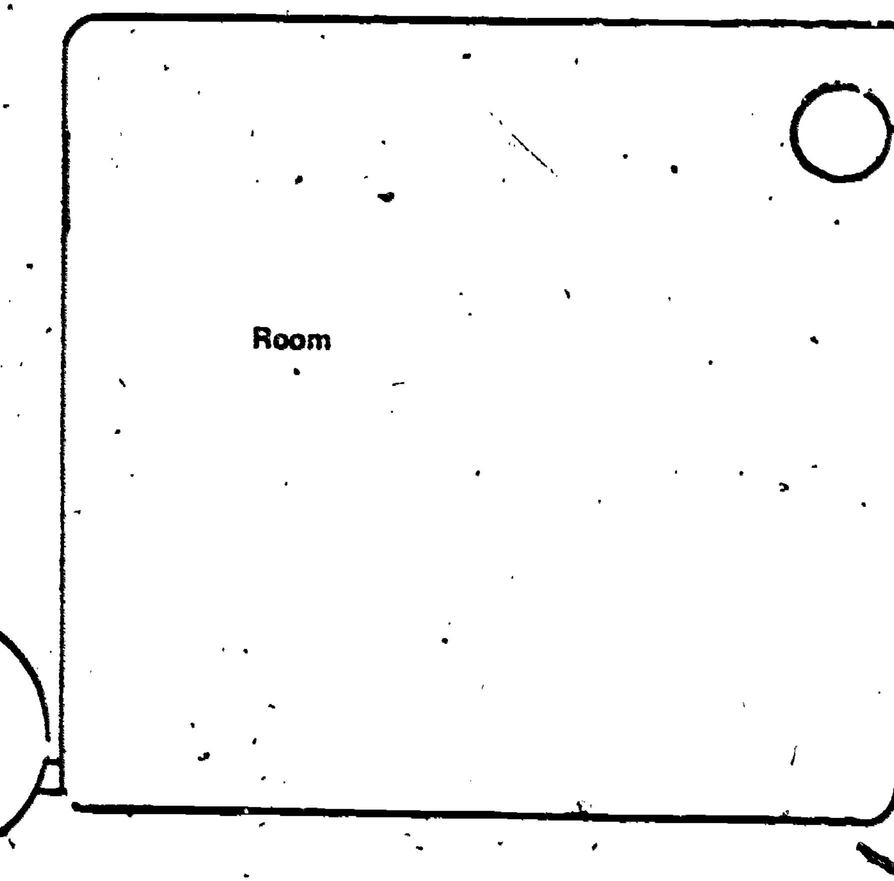
- The hot air is pushed out by the fan.
- The energy source is electricity.
- The hot coil heats the air in the tube.
- Electrical energy is converted to heat energy when it passes through the coil of wire.

Does a toaster or an electric stove use some or all of these sentences? Use parts (or all) of the sentences and tell how a toaster or electric stove works.

CENTRAL HEATING SYSTEM

3





Above is a picture of a home heating system. In some ways it works like the hair dryer. Take this outline drawing with you when you look at the school's heating system. Write these words in the proper place when you have seen the operation of the school heating system: PRIMARY SOURCE, FIRE BOX, JACKET or BOILER, MOVING DEVICE, THERMOSTATS (3).

Can you draw the wires leading from each thermostat to make the room warmer? Show your ideas to a friend.

FIELD GUIDE QUESTIONS

1. School Wiring

Are the wires covered or bare? Why?

How many wires are in a cable? Or are the wires in groups of three?

What is the first thing the electricity goes through at the building? Why?

Write in where you think the wires go inside the school.

2. Transmission Lines

Does the size of the wires change? Why?

Are the wires in a cable, or are they separate? Why?

Why are the wires so high off the ground?

Do the wires branch off at times? Why?

What are the containers that look like gray tanks of some kind on some poles called? What do they do?

How many supply lines lead into the transformer station? How many leave the station?

Write in what you think a transformer does.

3. Generating Station

What is the primary source of energy used in the station?

Does the station have an alternate primary source of energy they can use, if necessary?

What powers the turbine?

What does the generator do?

What are the main parts of the generator?

Write in the words that go in the blanks. Choose words from the scrambled list below:

mechanical

coal

heat

turbine

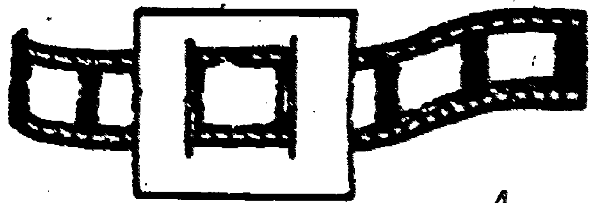
oil

generator

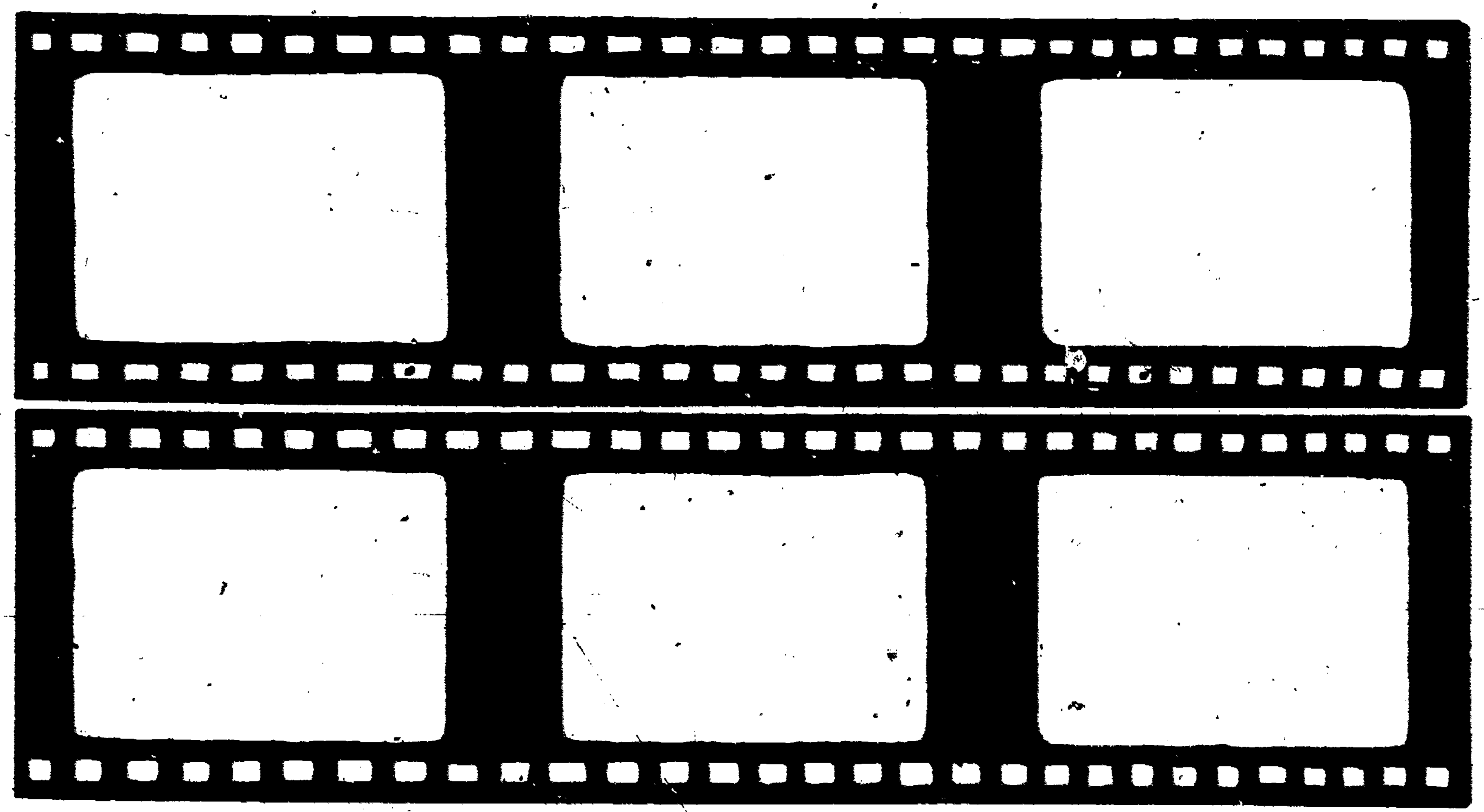
gas

The ______________ supplies the energy which is converted to ______________ in the boiler. Steam in the boiler is converted to ______________ energy in the ______________. The ______________ energy is converted to electrical energy in the ______________

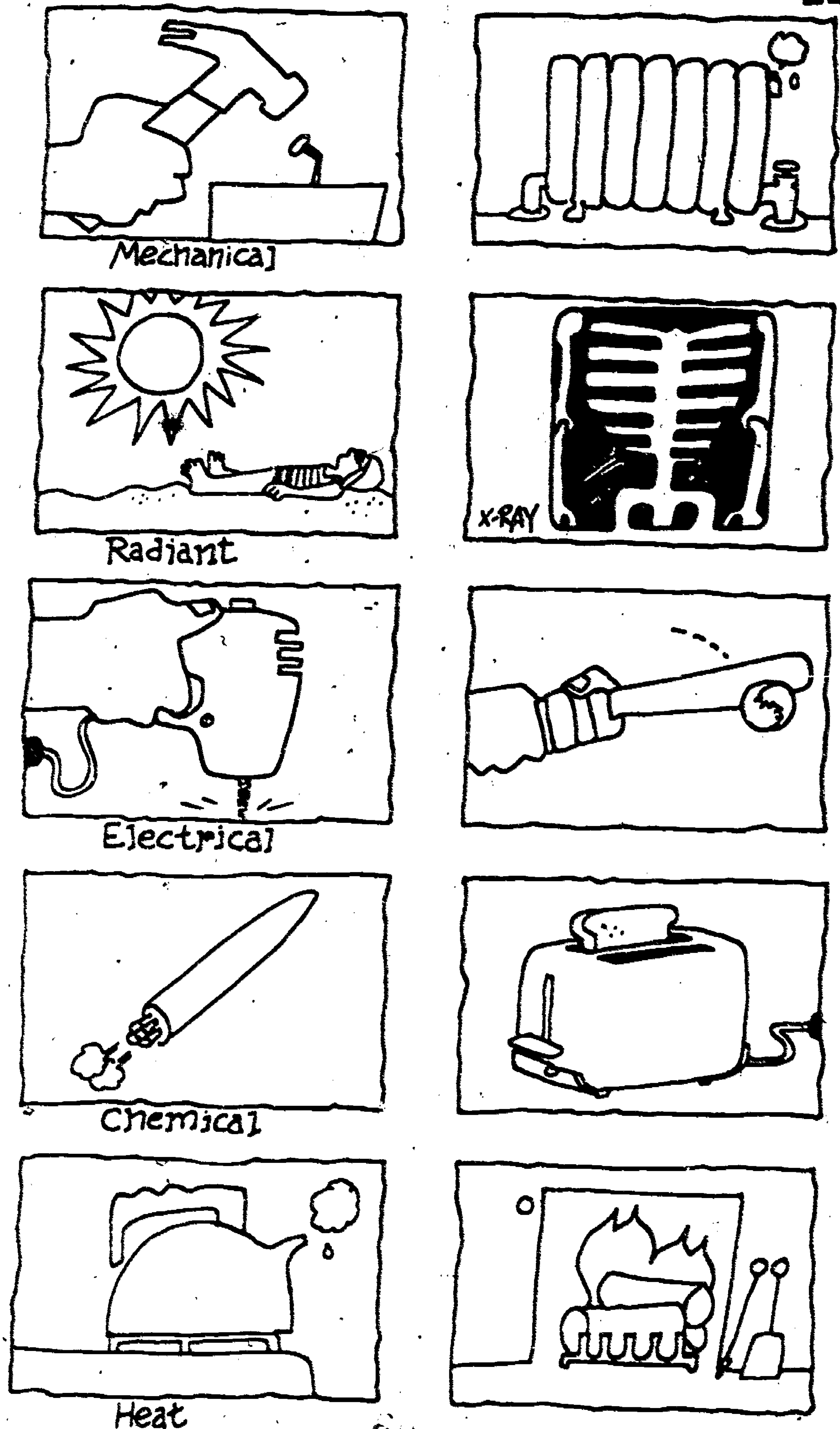
ENERGY IN ACTION

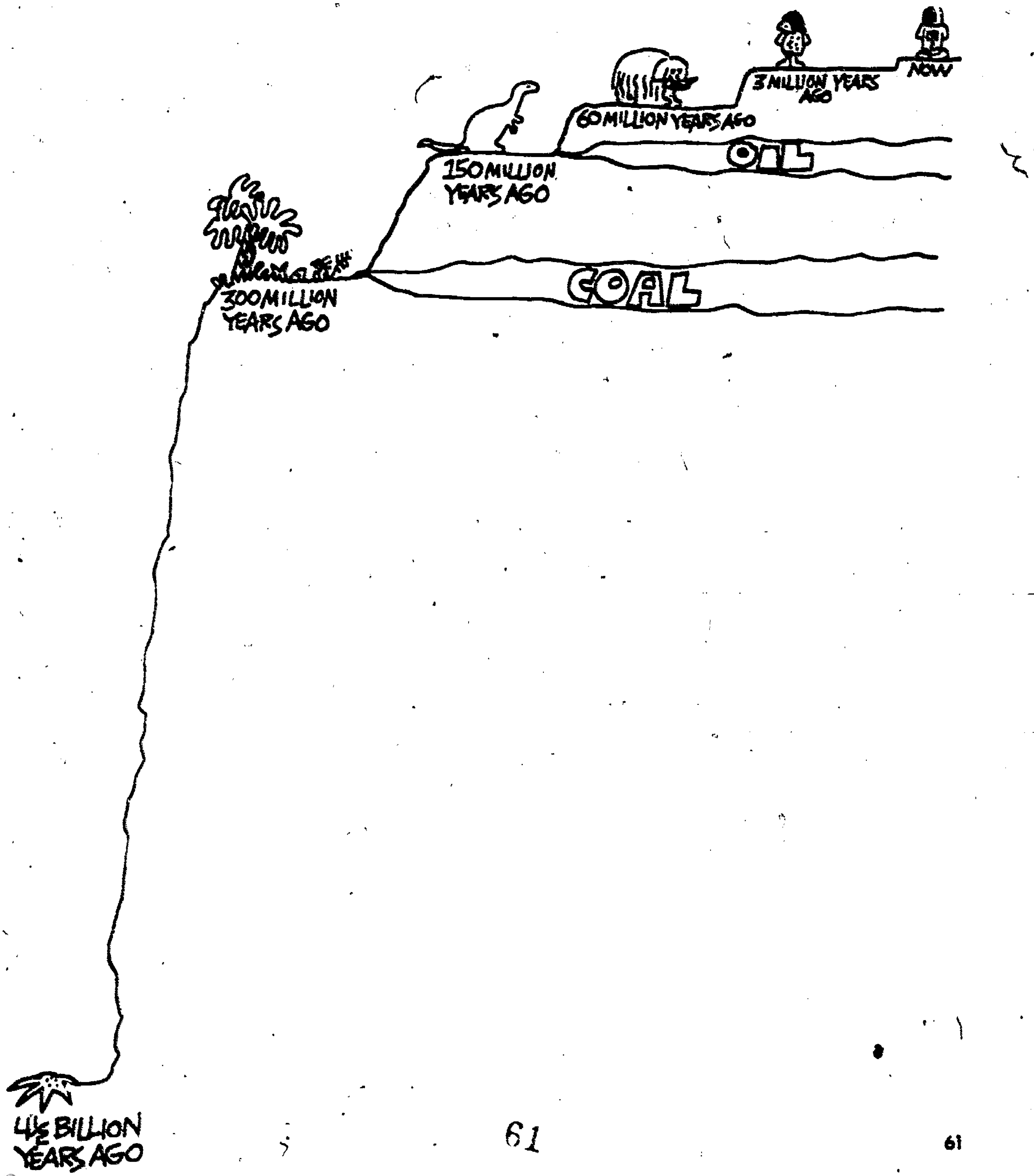


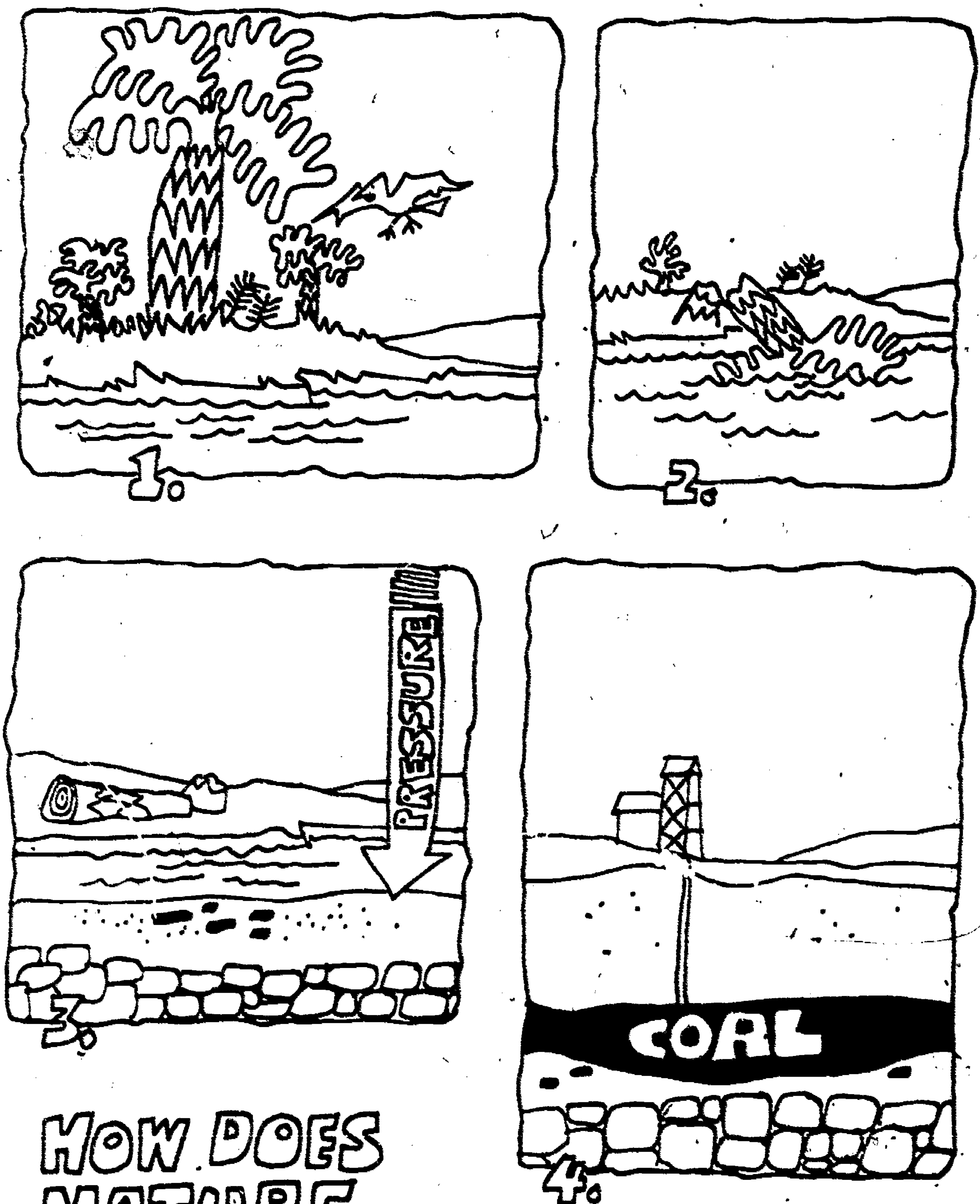
You can make a picture show about ENERGY IN ACTION. Cut out each picture. Then match as many of the pairs as you can. Tape the pairs together, then connect pairs with other pairs with tape and make a movie. Pull them through a small cardboard viewer like the one shown here. Write a story to tell when you show your movie. Tell where the energy comes from.



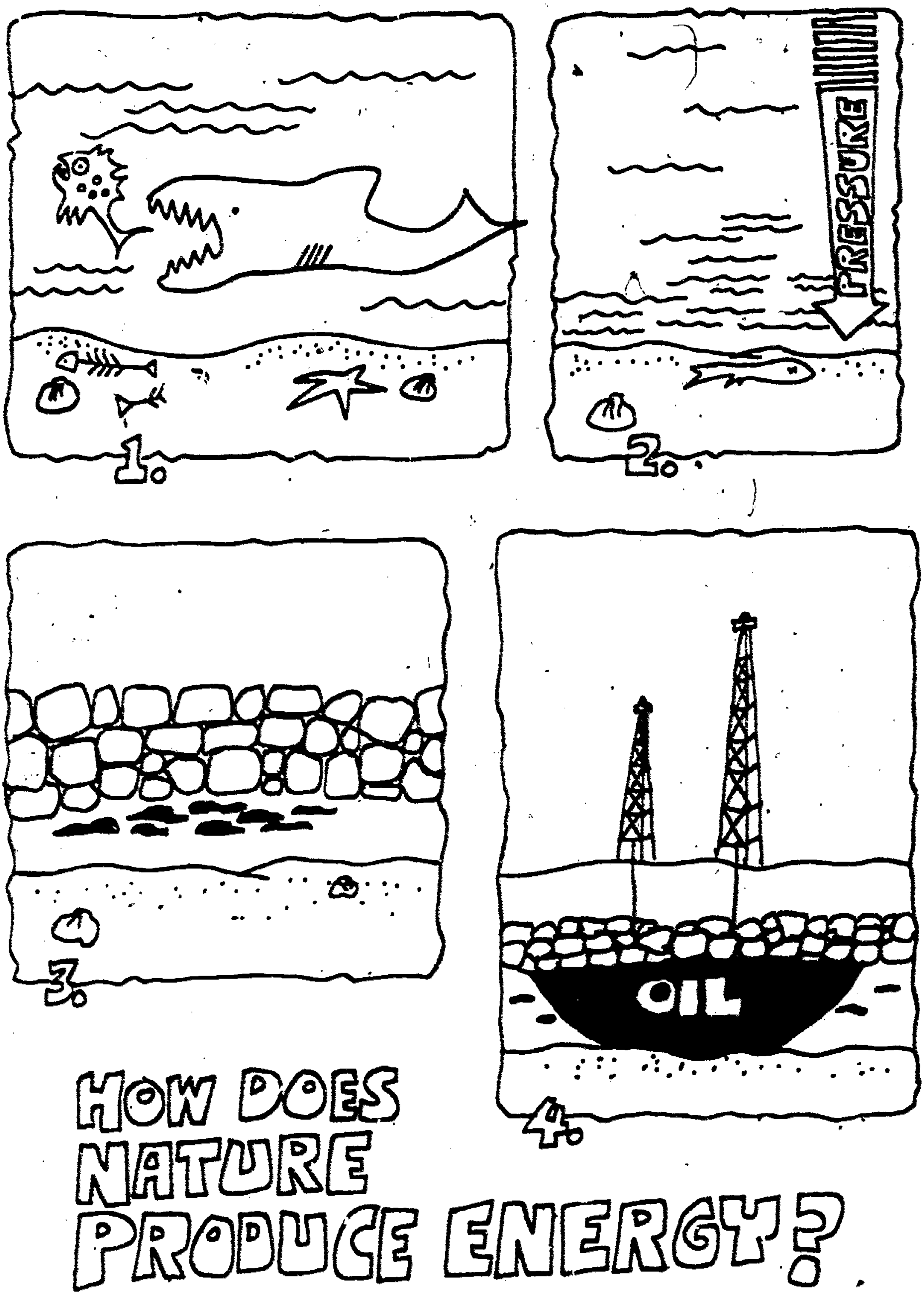
ENERGY IN ACTION



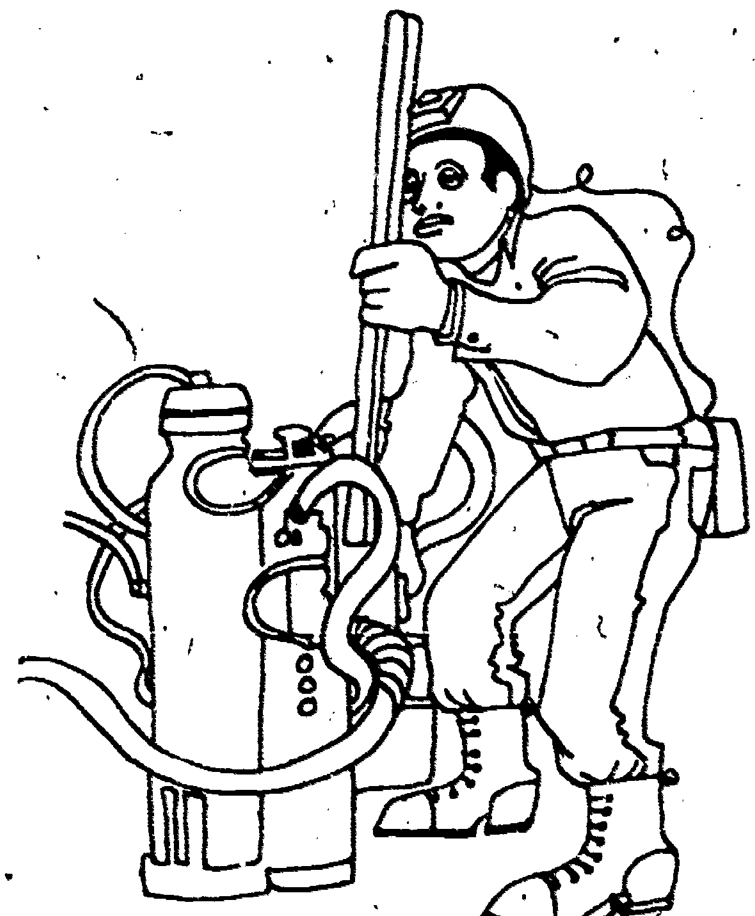

NOW
3 MILLION YEARS AGO
60 MILLION YEARS AGO
OIL
150 MILLION YEARS AGO
COAL
300 MILLION YEARS AGO
4½ BILLION YEARS AGO



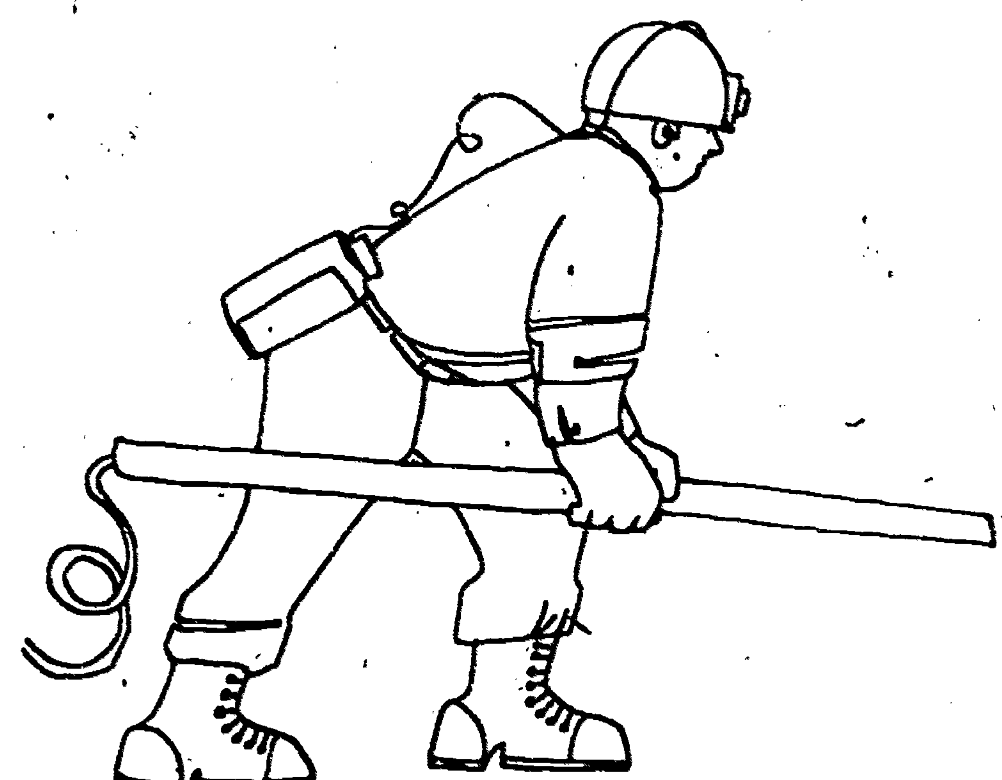
HOW DOES NATURE PRODUCE ENERGY?


PRESSURE
1.
2.
3.
OIL
4.
HOW DOES NATURE PRODUCE ENERGY?

Below are two miners from different parts of an underground mine. Cut these figures out and place each of them on a separate piece of paper. Draw in their working environment as well as you can. Draw in some of the dangers these people face. Tell the class which are instant dangers and which are longer-range dangers.

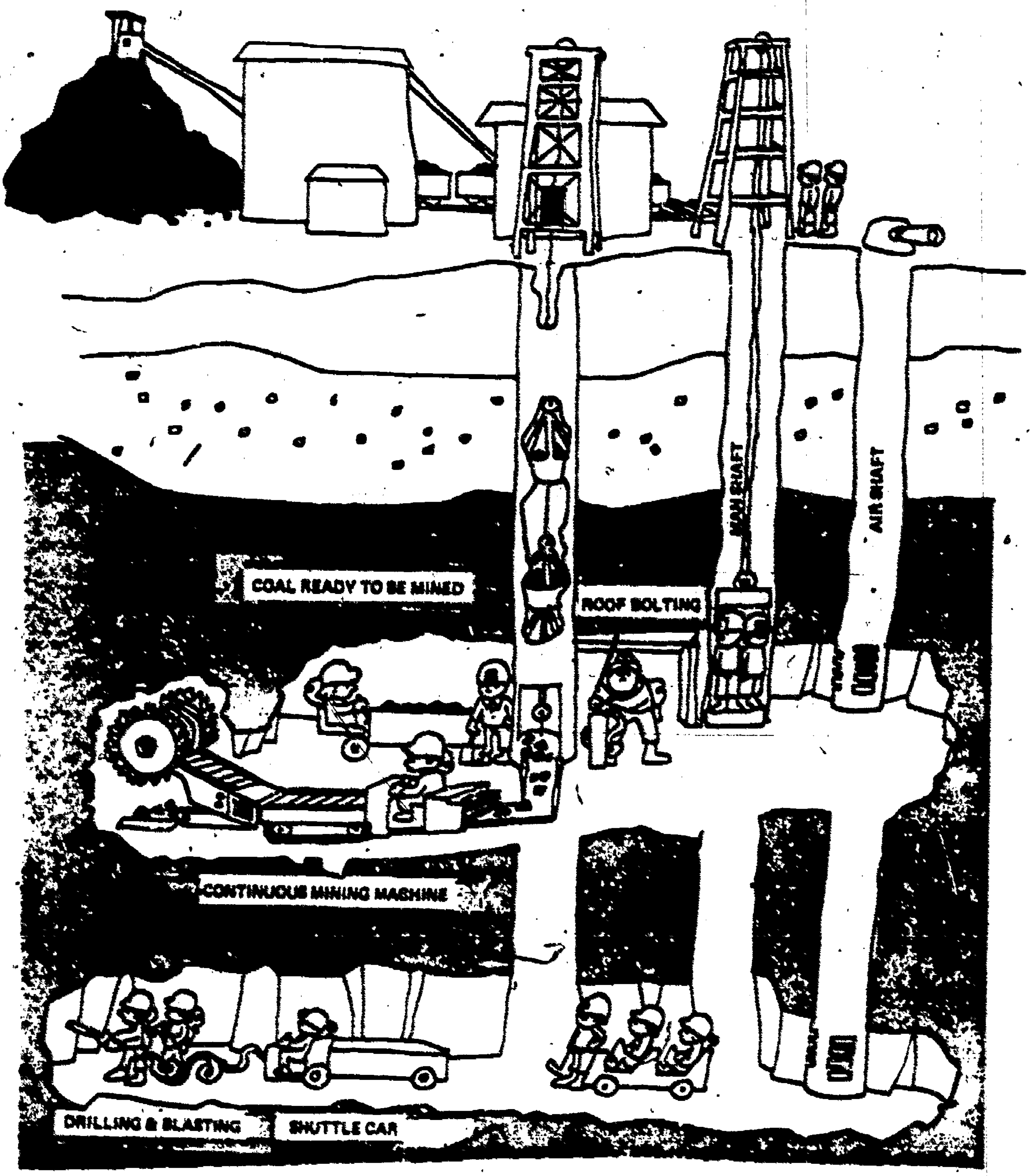


DETAIL: ROOF BOLT TIGHTENING

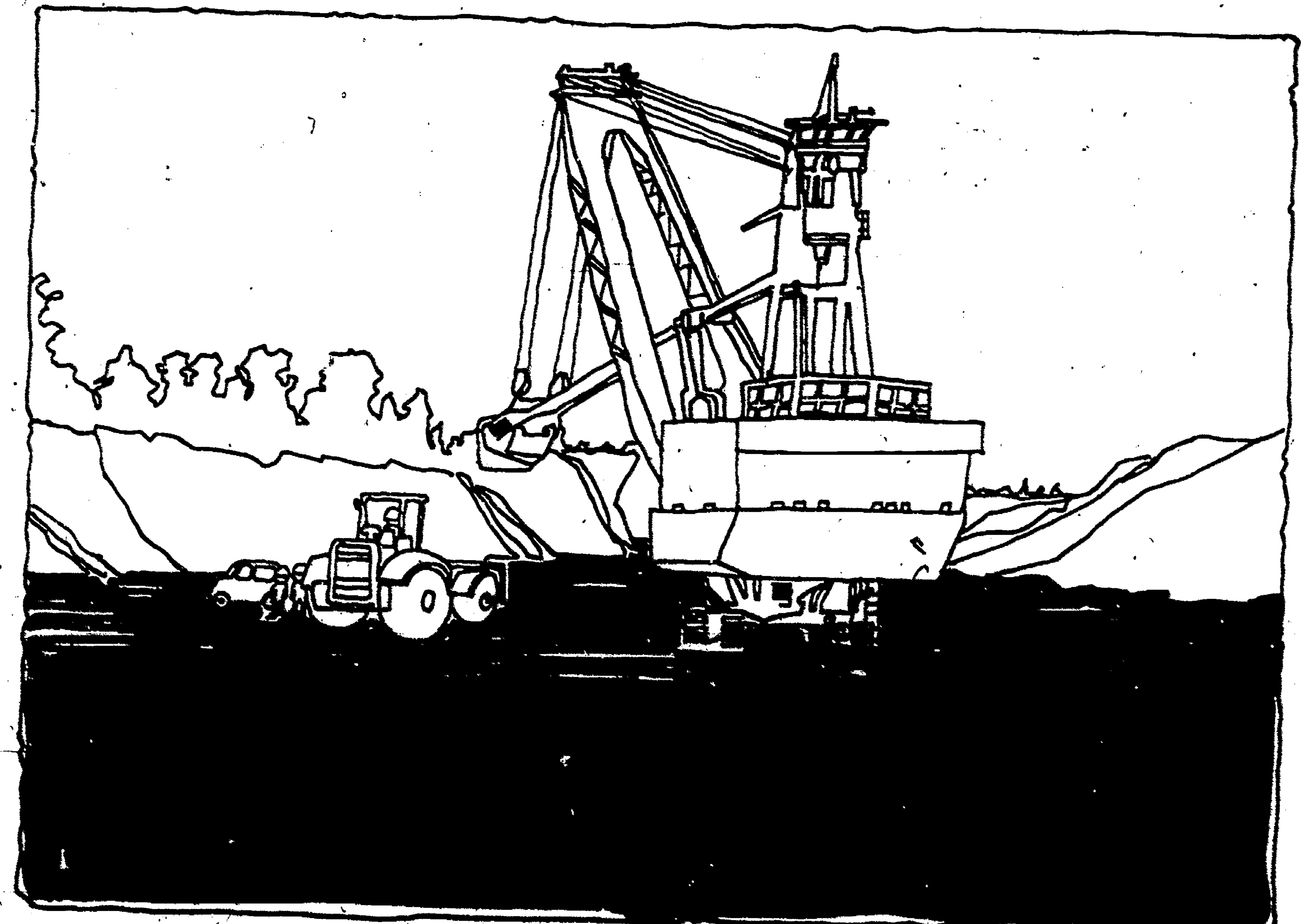


DETAIL: DRILLING and BLASTING

COAL MINING

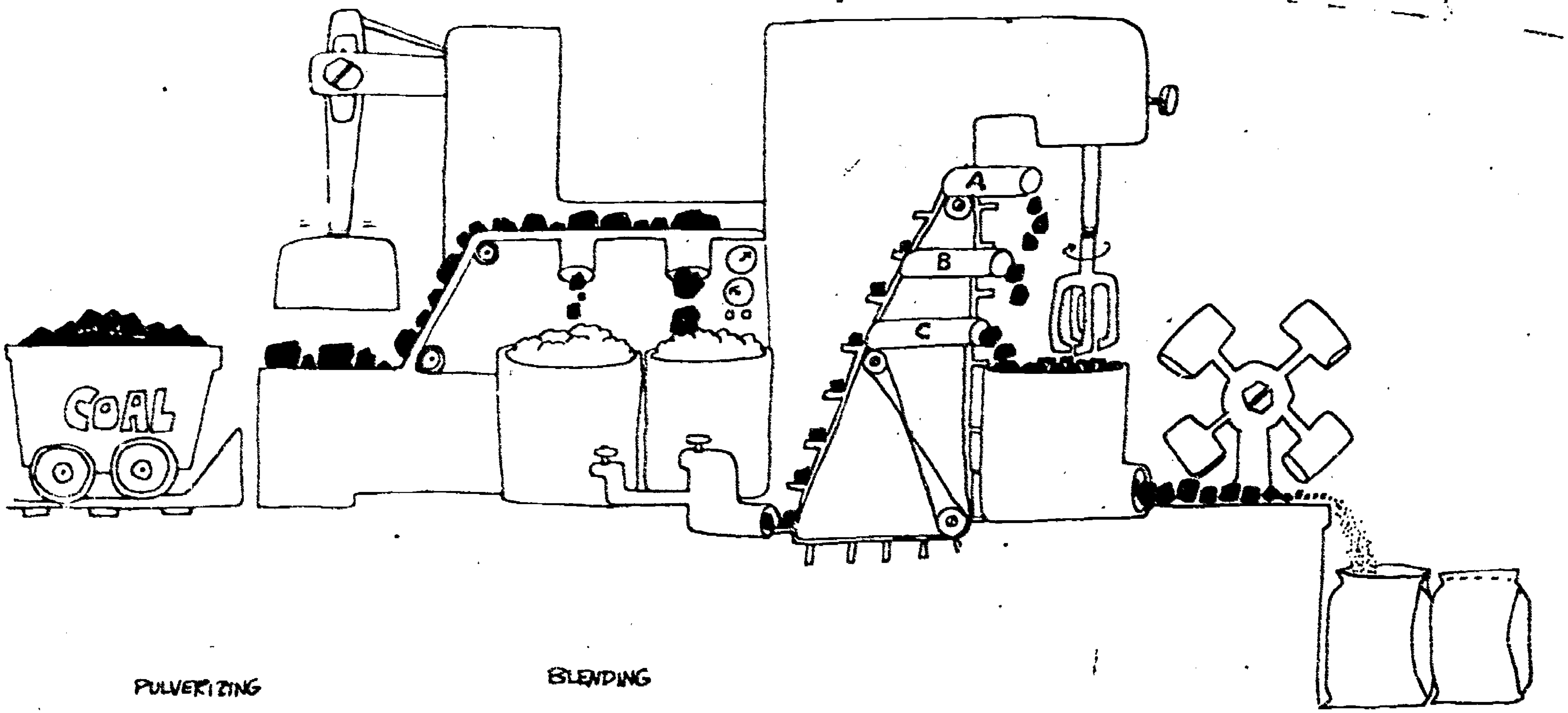

COAL READY TO BE MINED
ROOF BOLTING
MAIN SHAFT
AIR SHAFT
CONTINUOUS MINING MACHINE
DRILLING & BLASTING
SHUTTLE CAR

10



PROCESSING BITUMINOUS COAL

Match the words with the correct picture parts. Draw lines from the words to the right parts.



PULVERIZING

BLENDING

GRADING

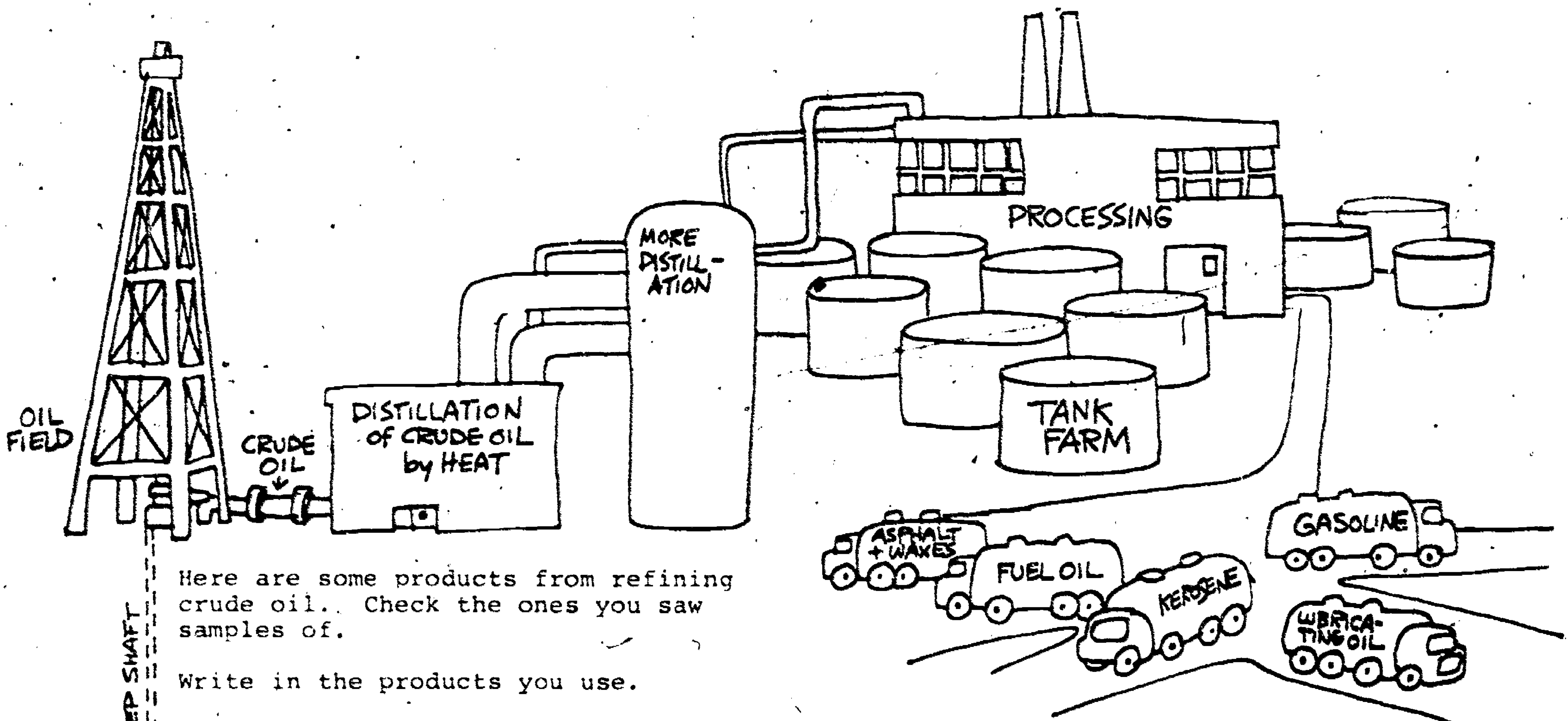
SIZING and WASHING

CRUSHING

Use the chart below tc classify the oil products.

	Color	Thick or Thin?
Crude Oil		
Gasoline		
Kerosene		
Light Household Oil		
Car Oil (Heavy Oil)		
Grease		
Wax		

PETROLEUM REFINING



Here are some products from refining crude oil. Check the ones you saw samples of.

Write in the products you use.

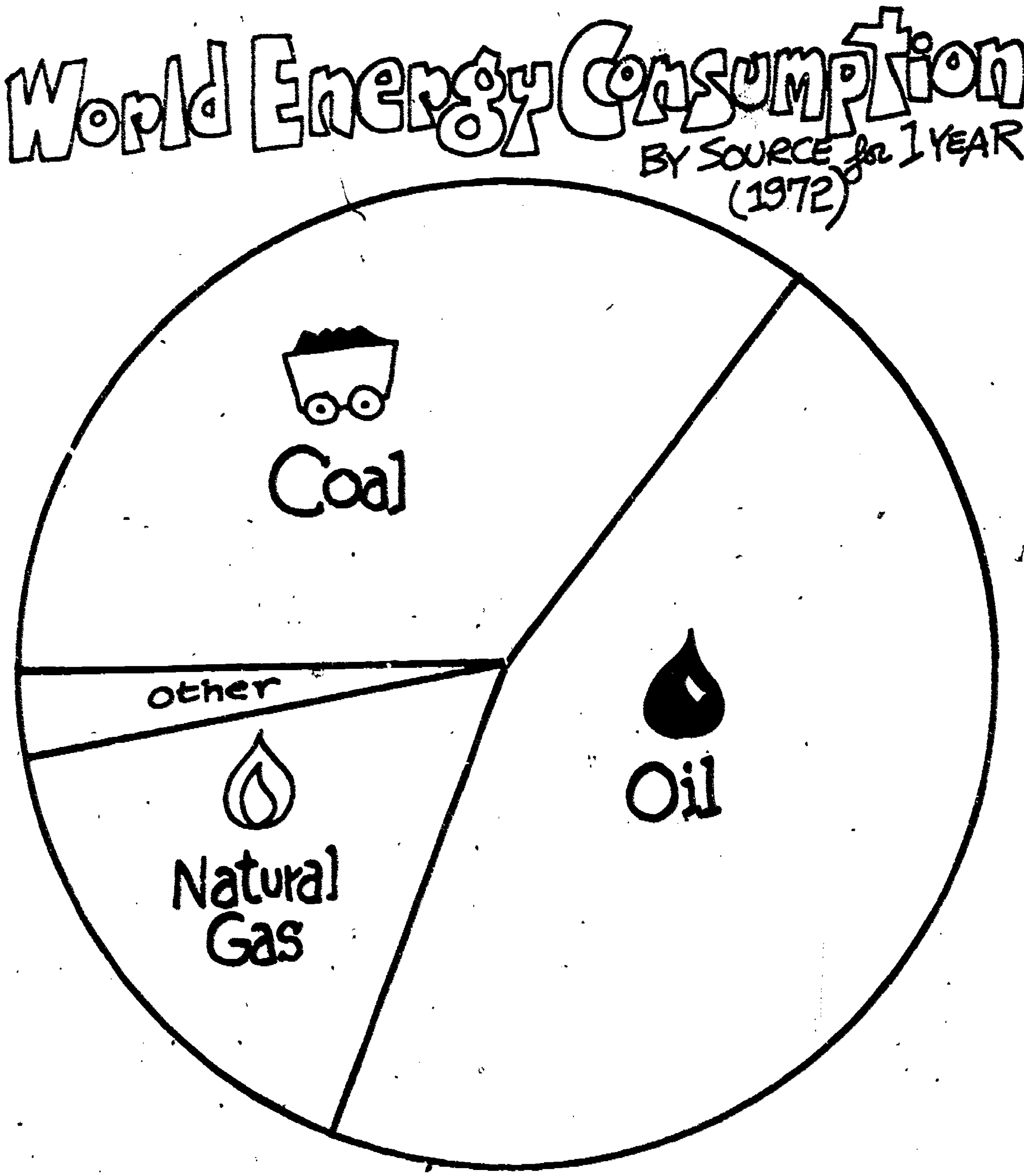
________ ________ ________

Draw a picture to show how one of these products is used. (Draw your picture on the back.)

Tell what you think distillation means:

____

____



1. Can you list the fossil fuels?

2. What fuels mights be listed under OTHER?

3. Write how you think the world depends on fossil fuels. If you prefer, write what you think the world would be like without the use of fossil fuels.

WHY ARE SOME PLACES WARM? WHY ARE SOME COLD?

15

Put a thermometer in different places of the classroom shown on the chart. Record on the chart the temperature of these places at different times of the day. Tell what you found out.

ROOM TEMPERATURE CHART

Location	9:00	11:00	1:00	3:00
Ceiling				
Floor				
Window				
Door				
Inside Wall				
Outside Wall				

1. Where is the room warmest?

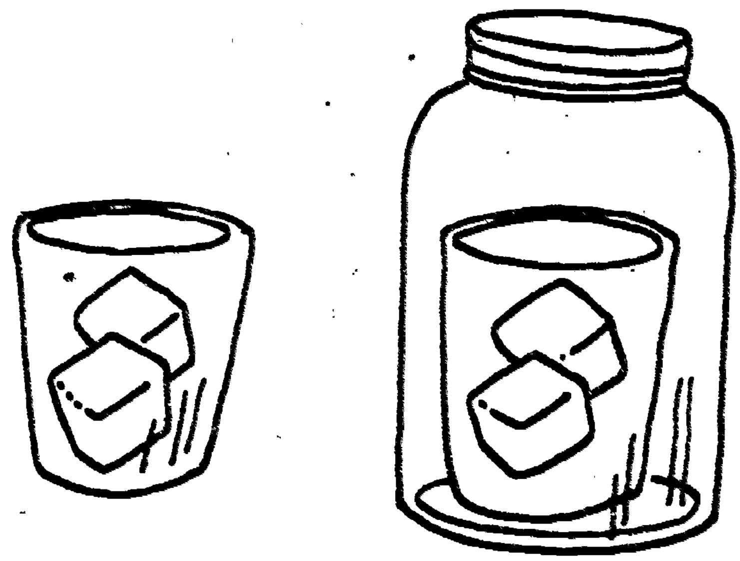
2. What is the coldest location?

3. Write in the ways you think heat is moving around the room.

4. Write in the ways you think heat is getting out of the room.

5. What are your ideas for keeping heat in the classroom?

Can this experiment give you a clue about how home heating and cooling bills can be cut? You will need to put an equal amount of ice into two small juice glasses. Place one juice glass into a larger jar and cover the jar with a lid. Note the time required to melt the ice in both glasses. Record this information on the chart.



	START	10 MIN.	15 MIN.	20 MIN.
OUT OF JAR				
IN JAR				

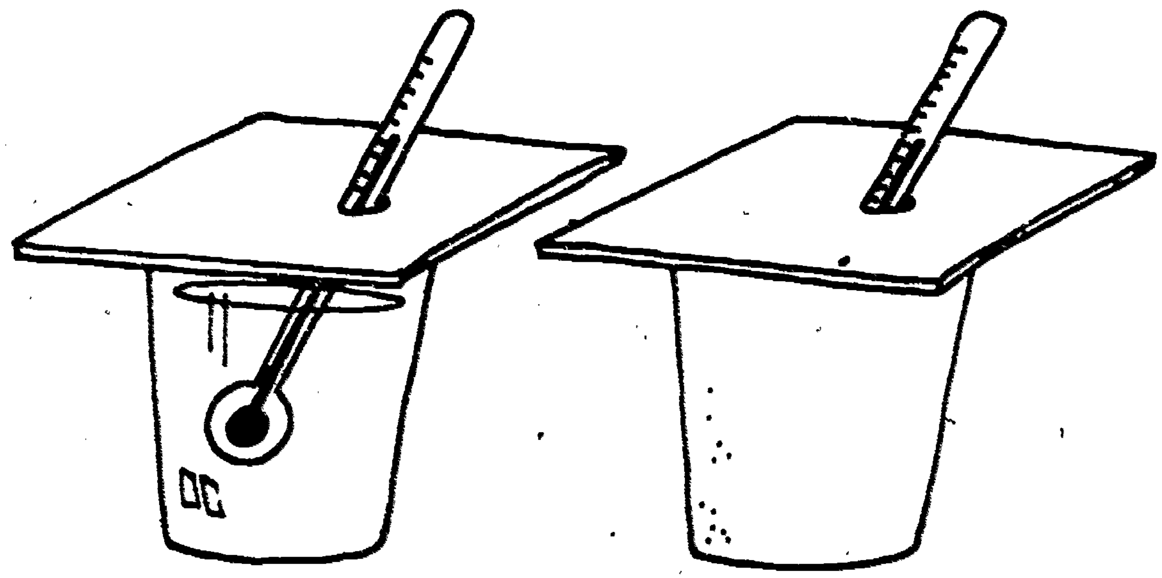
Which ice lasted longer?

Why?

What parts in a house act like the jar to keep the heat in or out?

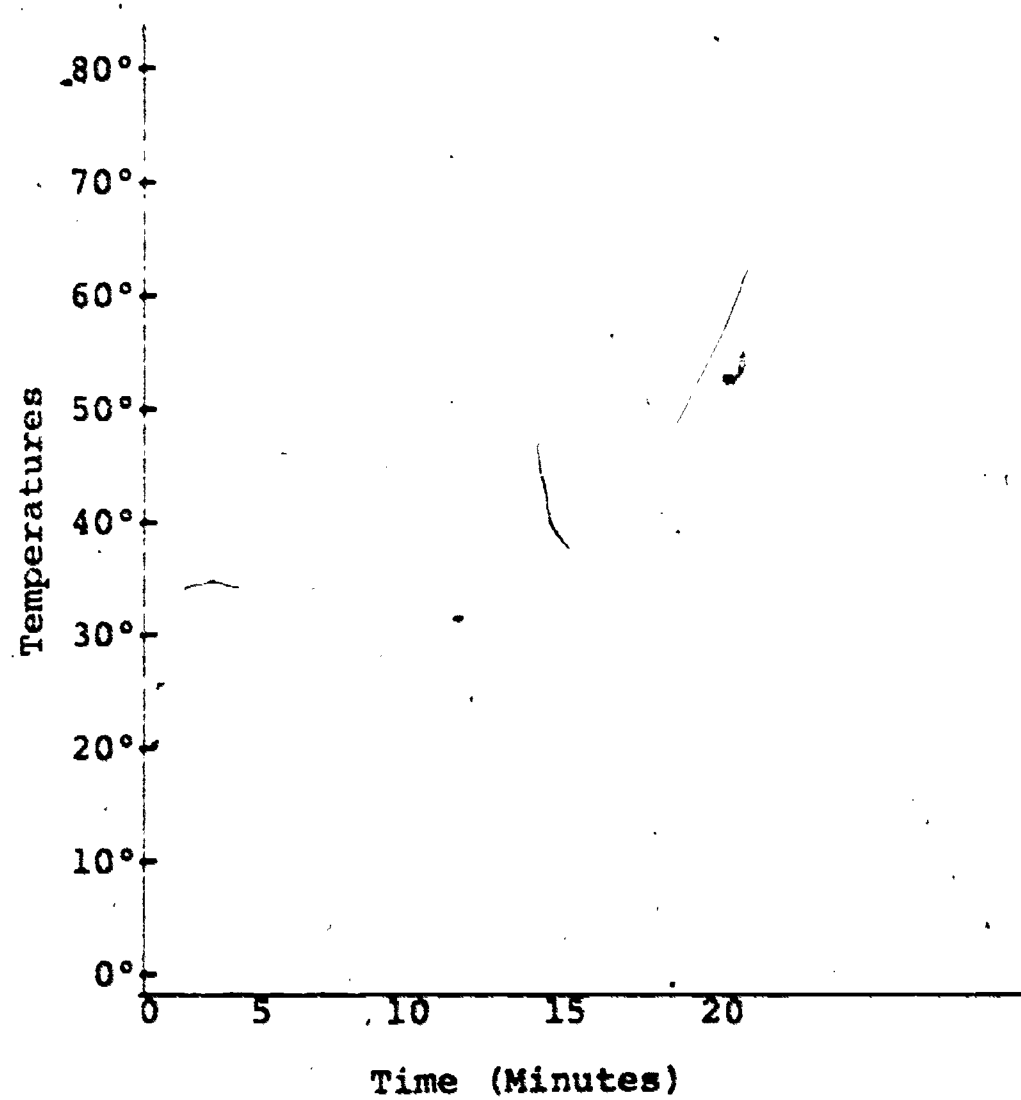
If you said storm windows and doors, you were correct. But tell why.

Use the chart to record the water temperatures in the two containers of water. Make a line graph to show which container lost heat faster.



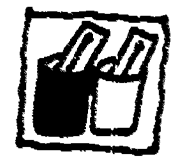
	START	10 MIN.	15 MIN.	20 MIN.
GLASS CUP				
STYRO-FOAM CUP				

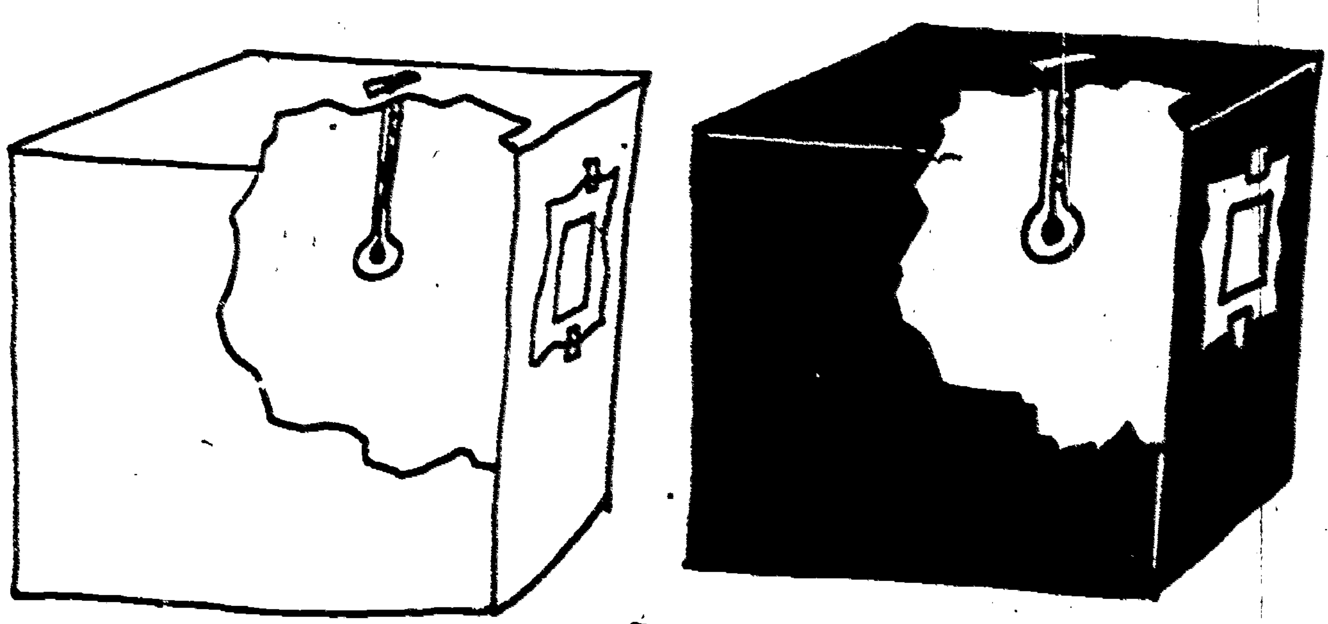
GRAPHING THE RESULTS



WHICH COLOR IS BETTER FOR ABSORBING AND CONVERTING THE SUN'S HEAT?

Put both of these boxes in a sunny place. Read and record the temperature inside the boxes every 5 minutes. Write in the chart what you find out. Then answer the questions.





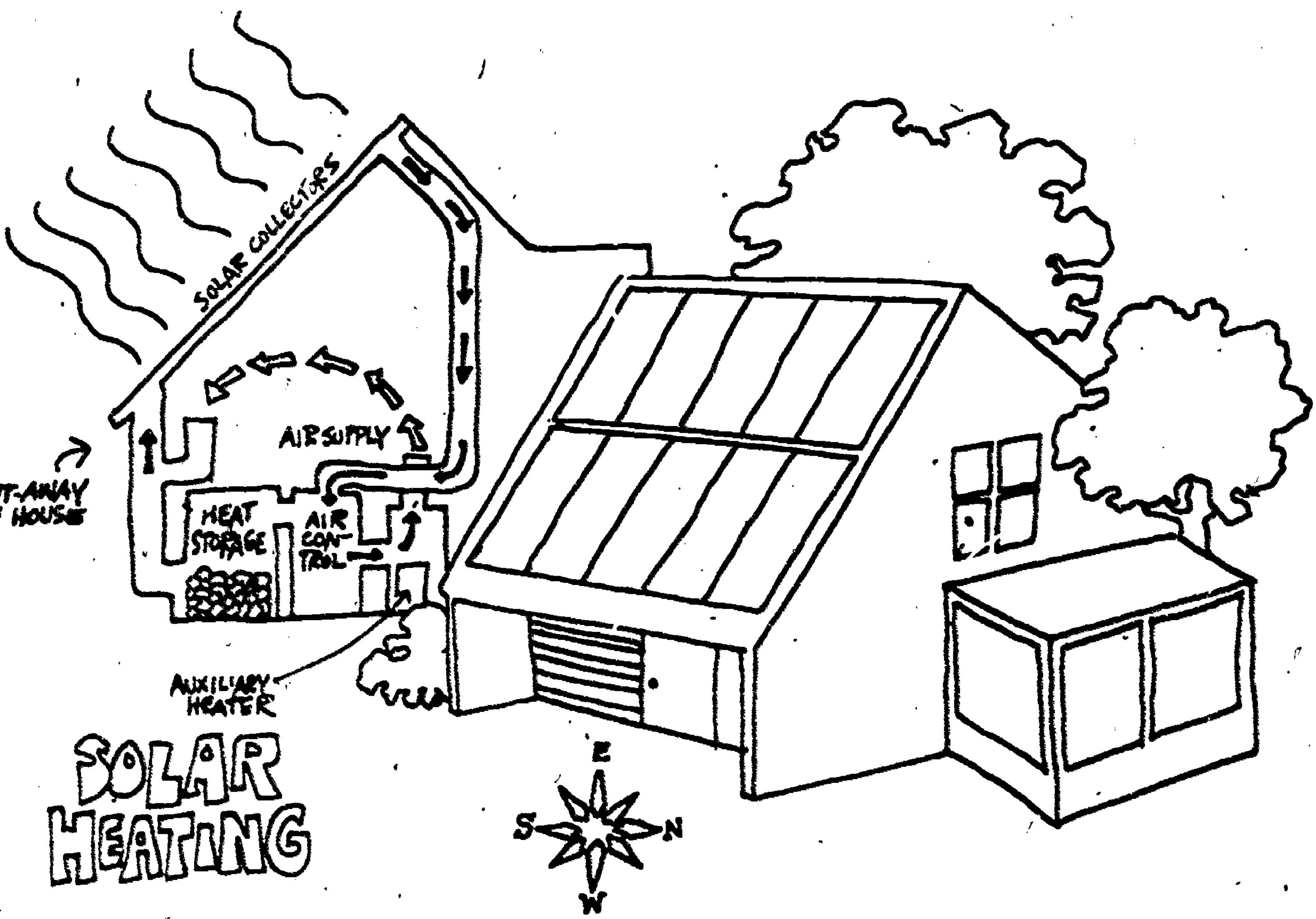
	START	10 MIN.	15 MIN.	20 MIN.
BLACK BOX				
WHITE BOX				

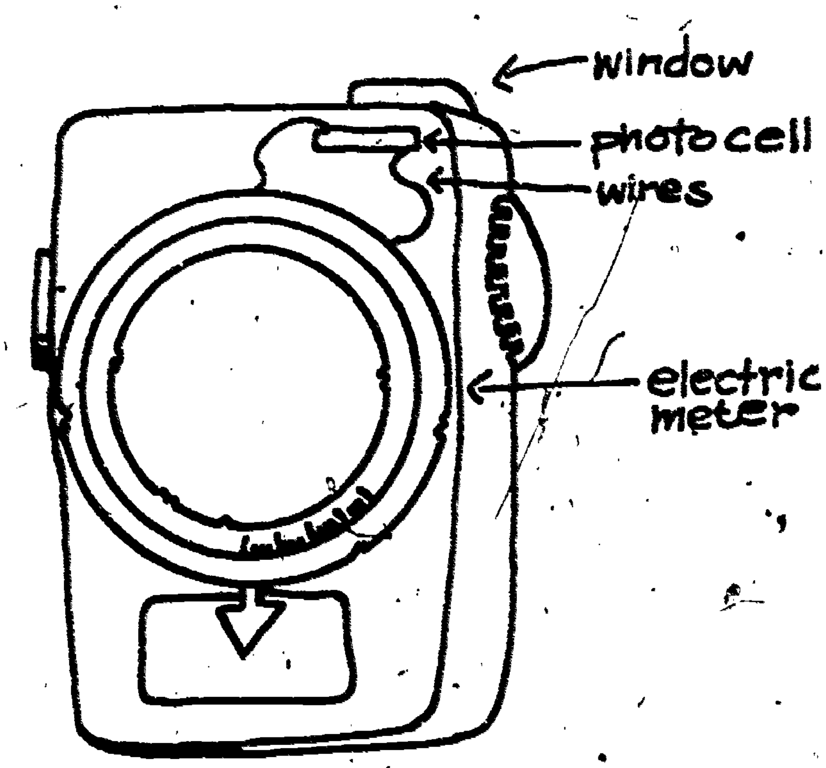
1. Which box (or tin can with water in it) got hotter? Why?

2. This experiment should give you some idea about the best color to use to paint the roof of a house. What do you think a roof should be painted to keep a house warmer? Why?

3. What color roof might keep a house cooler on hot summer days? Why?

4. Which color is better for absorbing and converting the sun's rays to heat?

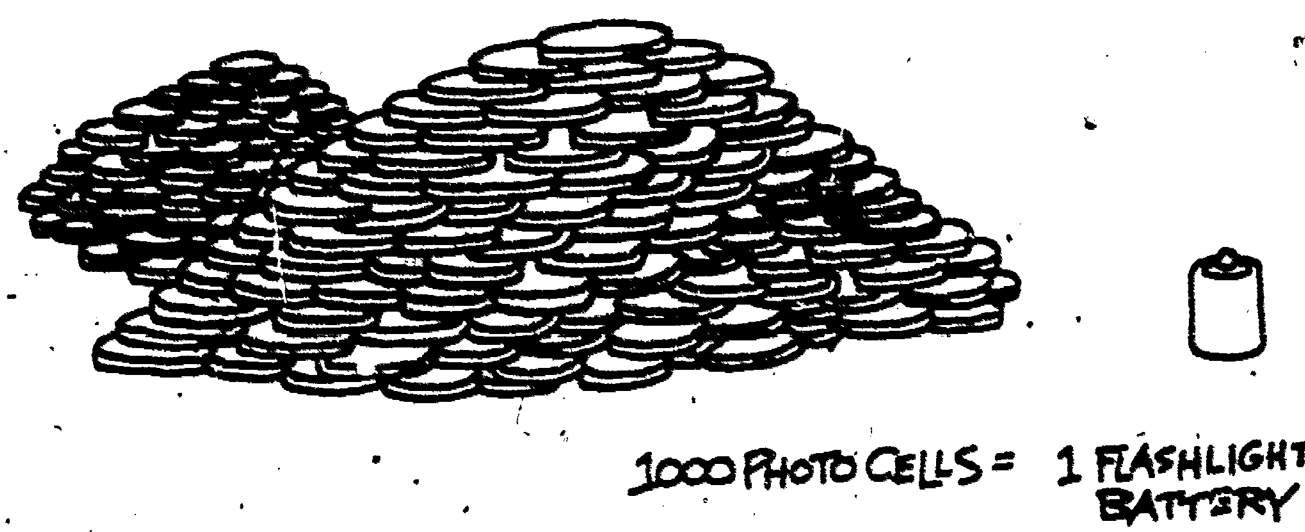

SOLAR COLLECTORS
AIR SUPPLY
CUT-AWAY OF HOUSE
HEAT STORAGE
AIR CON-TROL
AUXILIARY HEATER
SOLAR HEATING
E
S
N
W



Light enters the window and shines on the photo cell.

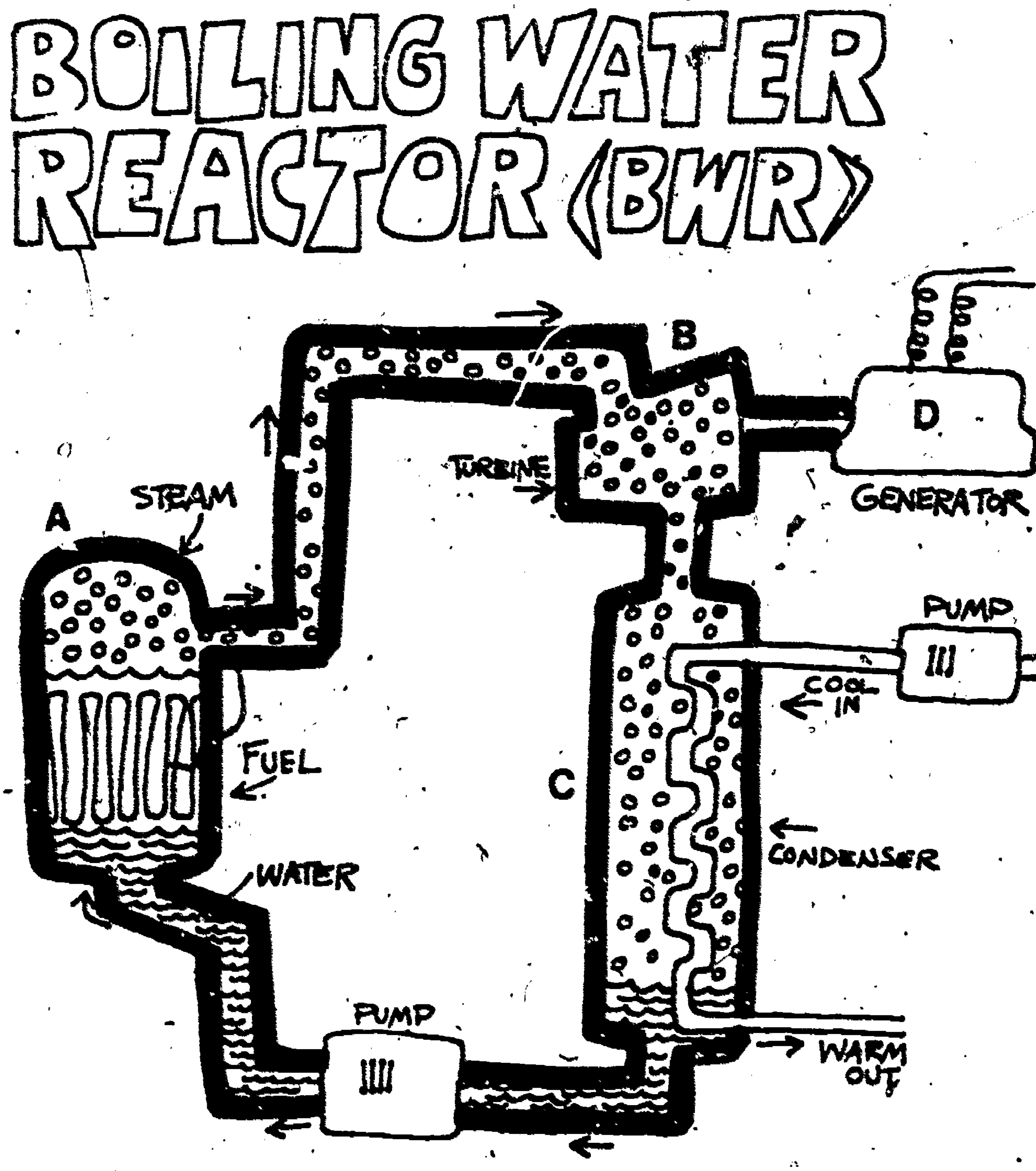
Photo cell converts light energy to electrical energy.

The electric meter registers the amount of electricity produced. (More light means more electricity.)



How does this picture suggest why we don't use photo cells in flashlights?

The nuclear reactor produces electricity. Take your finger and trace the steps in the nuclear production of electricity, starting with the reactor (A) and ending with the generator (D). Then answer the questions below.



A, B, C, or D?

1. Where is the water changed to steam?
2. Where is the steam changed back to water?
3. Where is steam converted to mechanical work?
4. Where is the electricity made?

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